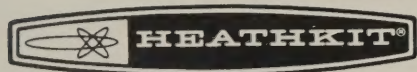


Assembly
and
Operation
of the



SOLID-STATE SSB RECEIVER

MODEL SB-303



HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

N7COT
WAGNER M. ROBINSON

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ALIGNMENT

- () Turn on your high input impedance voltmeter and allow it to warm up.

NOTE: The Receiver can be aligned with instruments or without instruments. Instrument alignment may result in a slight increase in sensitivity. However, it requires the use of

an RF generator that can deliver a signal from 3.5 MHz to 30 MHz. If a generator is available, plug it in and turn it on at this time to allow it to warm up. **DO NOT USE A VOLT-OHMMETER OR LOW-IMPEDANCE METER DURING THE ALIGNMENT PROCEDURE.**

ALIGNMENT PREPARATION

PRESETTING CONTROLS

- (☒) Set the front panel controls and switches to the following positions:

FUNCTION – STBY
CONVERTER – HF
PRESELECTOR – Any
R.F. ATTEN – Fully clockwise
BAND – 3.5
MAIN TUNING – 0.00
AGC – OFF
RF GAIN – Fully clockwise and pushed in
MODE – USB
AF GAIN – PWR OFF

Refer to Figure 5 (fold-out from Page 110) for the following steps.

- () Set each of the following controls on the IF/audio circuit board to the center of its rotation: BIAS ADJ, METER ZERO, and METER FULL SCALE.

- () Set the +15 ADJ control on the power supply/BFO circuit board to the center of its rotation.

REAR PANEL CONNECTIONS

- (☒) Insert the LMO load into the LMO OUT phono socket. (47 Ω)

- (☒) Connect an 8 Ω speaker to the SPEAKER phono socket.

NOTE: The Receiver was wired for operation from either a 120 Vac or 240 Vac power source. In the following steps, connect the Receiver to the ac power source for which it has been wired.

CAUTION: When the line cord plug is connected to an ac outlet, ac voltage will be present at several places under the chassis. Be careful that you do not contact this voltage or an electrical shock may result.

- (☒) Insert the female end of the power cord into the 120/240 Vac power socket. Plug the power cord into an ac power source.

PRELIMINARY ADJUSTMENTS

- (X) Adjust your voltmeter to read +15 volts dc.
- (X) Connect the voltmeter negative lead to the Receiver chassis assembly.
- (X) Rotate the AF GAIN control to the 9 o'clock position.
- (X) Turn the FUNCTION switch to OPR.
- () Refer to Figure 6 and touch or connect the meter dc volts lead to lug 10 of the FUNCTION switch. This lug has an orange wire connected to it.

Refer to Figure 5 (fold-out from Page 110) for the location of internal controls in the following steps.

- (1) Adjust the +15 ADJ control for +15 Vdc.
- (1) Refer to Figure 7 and position the meter dc volts lead against the AGC connector on the RF Amplifier Switch-Board.
- (1) Adjust the BIAS ADJ control for +3.5 Vdc.
- (1) Disconnect the voltmeter test leads and temporarily set them aside.
- (1) Adjust the METER ZERO control for a zero S-meter reading.

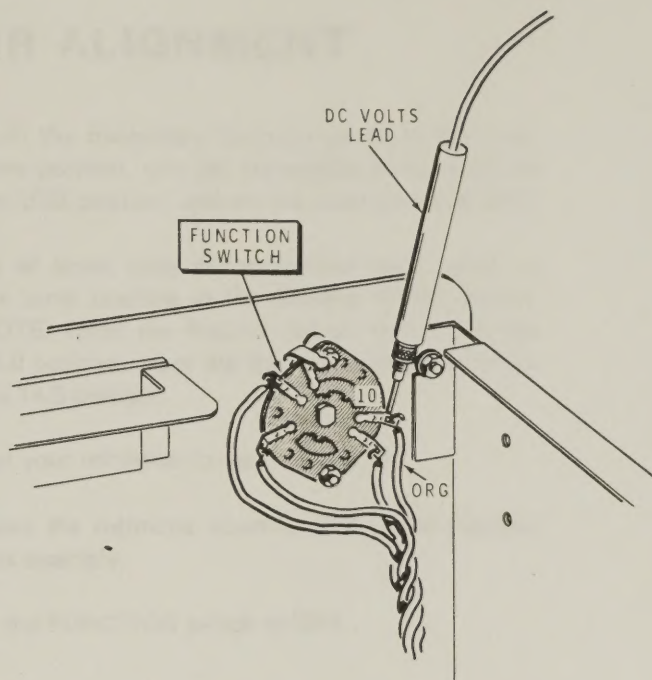


Figure 6

- (1) Rotate the RF GAIN control fully counterclockwise.
- (1) Adjust the METER FULL SCALE control until the S-meter needle just "pegs."
- (1) Rotate the RF GAIN control fully clockwise.
- () Turn the FUNCTION switch to the STBY position.

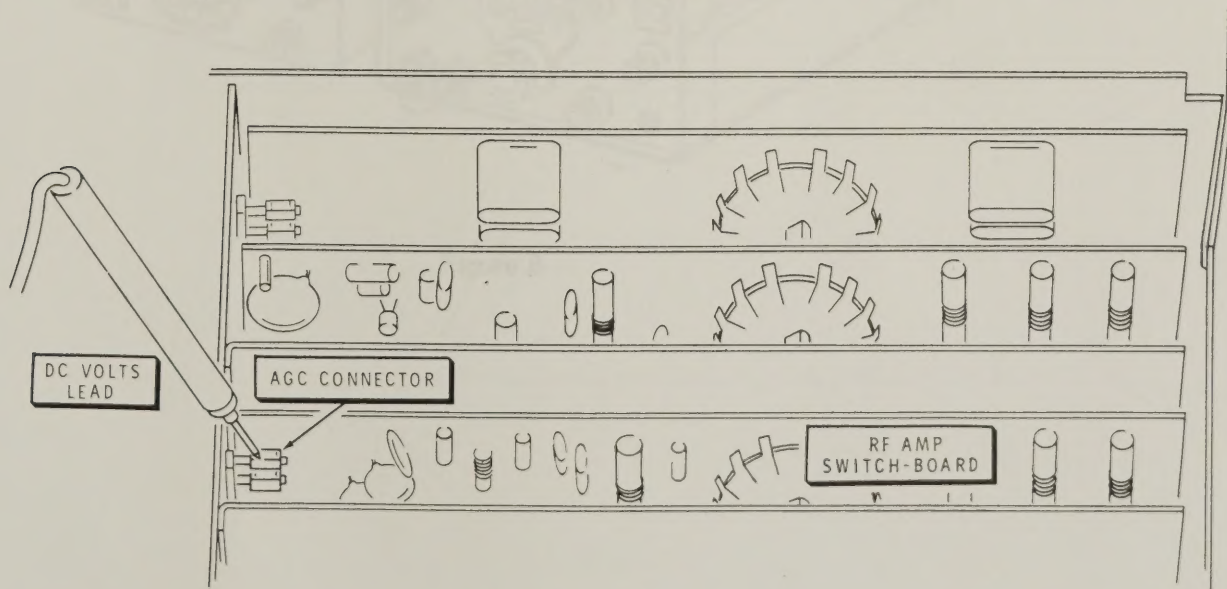


Figure 7

PRELIMINARY AGREEMENT



- 1. The first part of the agreement is the...
- 2. The second part of the agreement is the...
- 3. The third part of the agreement is the...
- 4. The fourth part of the agreement is the...
- 5. The fifth part of the agreement is the...
- 6. The sixth part of the agreement is the...
- 7. The seventh part of the agreement is the...
- 8. The eighth part of the agreement is the...
- 9. The ninth part of the agreement is the...
- 10. The tenth part of the agreement is the...

1. The first part of the agreement is the...

2. The second part of the agreement is the...

3. The third part of the agreement is the...

4. The fourth part of the agreement is the...

5. The fifth part of the agreement is the...

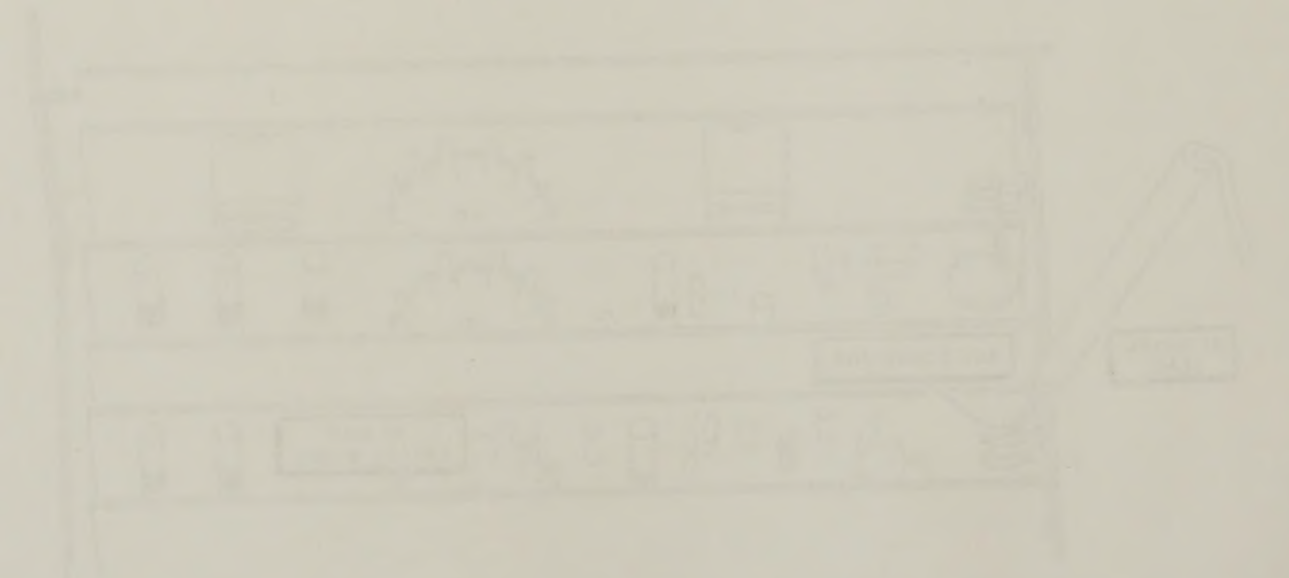
6. The sixth part of the agreement is the...

7. The seventh part of the agreement is the...

8. The eighth part of the agreement is the...

9. The ninth part of the agreement is the...

10. The tenth part of the agreement is the...



HETERODYNE OSCILLATOR ALIGNMENT

If you have a Heath Model SB-400 or SB-401 Transmitter and plan to use it with this Receiver for transceive operation, perform the following four steps. Otherwise, disregard the following four steps. If at any time in the future you plan to transceive with one of these transmitters, you should perform the following "Heterodyne Oscillator Alignment."

- (✓) 1. Position the Receiver and your transmitter as shown in Figure 8.
- (✓) 2. Connect a previously prepared 24" length of RG-62U (large) coaxial cable from the HFO OUT phono socket on the Receiver rear panel to the HET. OSC. phono socket on the transmitter rear panel.

- () 3. Turn the transmitter function switch to the transceive position, turn the transmitter mode switch to the USB position, and set the main tuning to 0.00.
 - () 4. At all times, keep the transmitter band switch in the same position as the Receiver BAND switch. NOTE: When the Receiver BAND switch is in the 15.0 position, place the transmitter band switch in the 14.0 position.
- () Adjust your voltmeter to read +5 volts dc.
- () Connect the voltmeter common lead to the Receiver chassis assembly.
- (✓) Turn the FUNCTION switch to OPR.

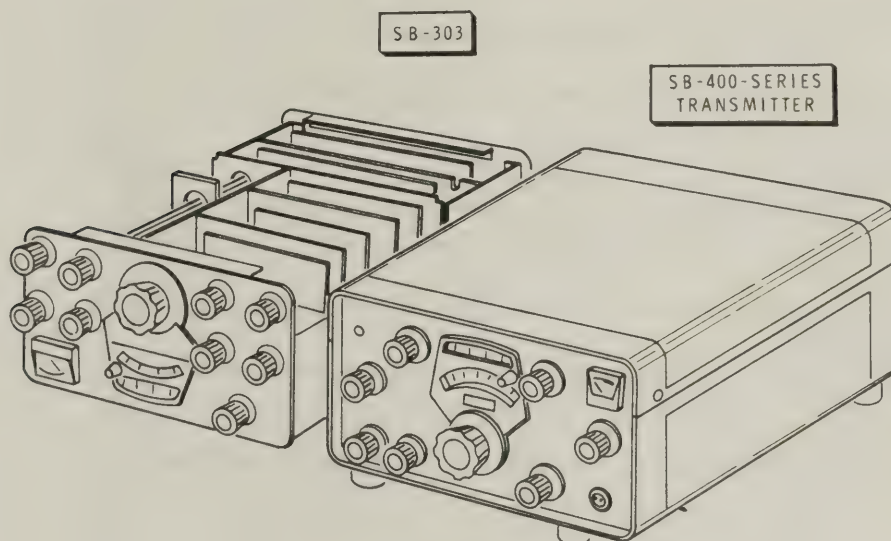


Figure 8

Refer to Figure 9 and the chart on Page 115 for the following steps.

- () Position the meter dc volts lead against the TP connector pin on the heterodyne oscillator Switch-Board.

The coils on the heterodyne oscillator Switch-Board will be adjusted in the following chart. Rotate each coil slug slightly clockwise and/or counterclockwise to obtain a peak meter reading. Then rotate the coil slug either clockwise (CW) or counterclockwise (CCW) as indicated to obtain a voltage decrease in the meter reading. Use the long end of the small plastic alignment tool in these adjustments.

NOTE: Four of the coils that will be adjusted have two coil slugs. To reach the bottom slug, carefully slide the alignment tool through the hole in the top slug as shown in Figure 10. Be careful not to rotate the top slug when adjusting the bottom slug.

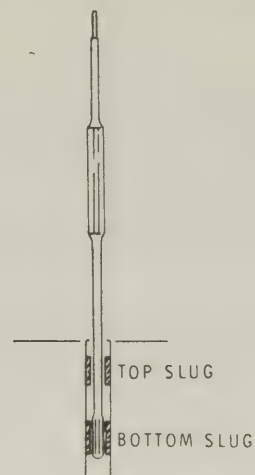


Figure 10

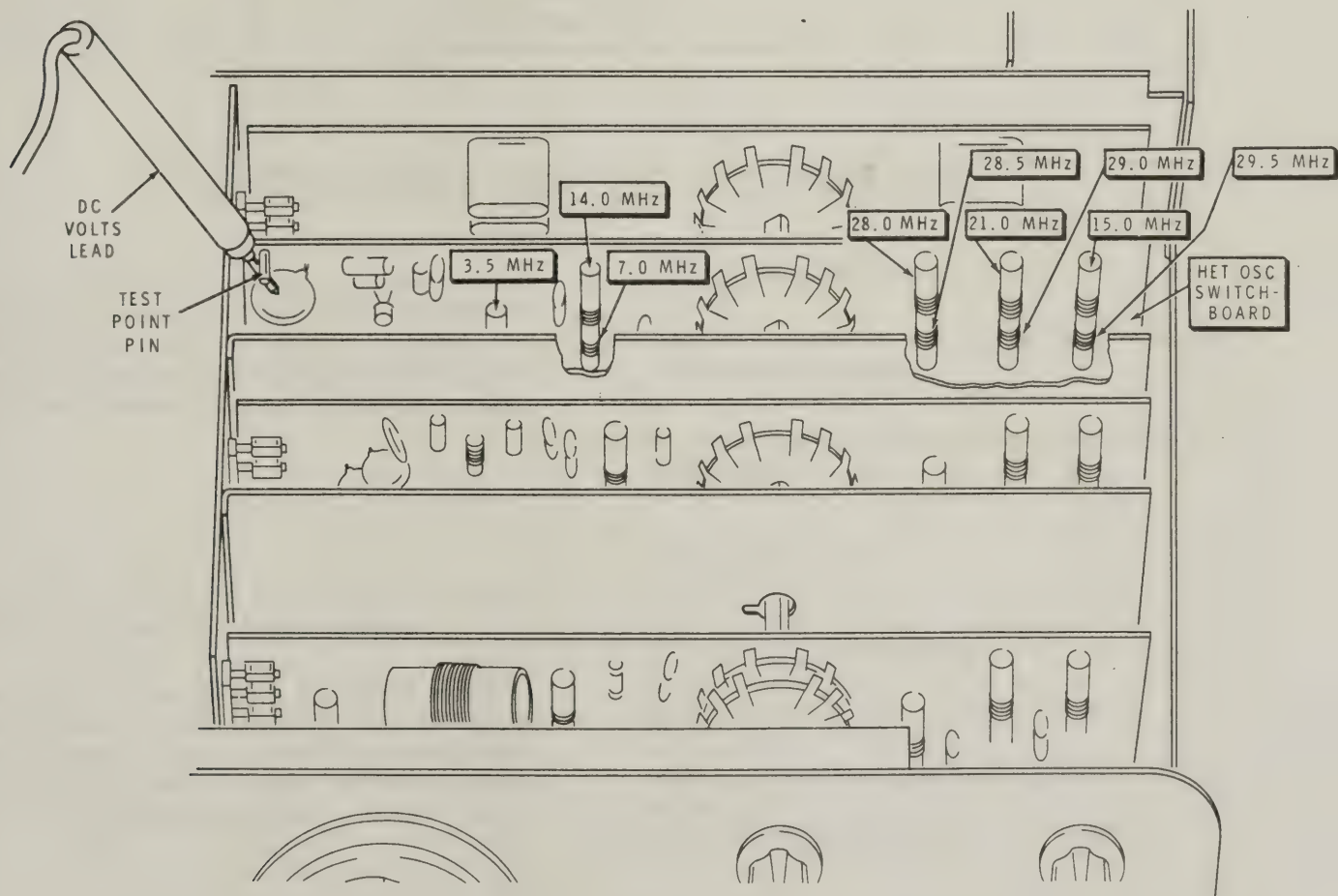


Figure 9

Complete the following adjustments:

BAND SWITCH POSITION AND HET OSC COIL	ROTATE THE SLUG FOR <u>PEAK VOLTAGE</u>. THEN ROTATE IT FOR THE AMOUNT OF VOLTAGE <u>DECREASE</u> SHOWN BELOW. NOTE: IF YOU ENCOUNTER A SECOND PEAK AS YOU ROTATE THE SLUG, DECREASE THE VOLTAGE FROM THE SECOND PEAK.
3.5, L114 7.0, L115 14.0, L116 15.0, L117 21.0, L118 28.0, L119 28.5, L121 29.0, L122 29.5, L123	3.0 Clockwise, 0.5 V 6.5 Counterclockwise, 0.5 V 13.7 Clockwise, 0.3 V 14.7 Clockwise, 0.3 V 20.9 Clockwise, 0.1 V 27.9 Clockwise, 0.1 V 28.4 Counterclockwise, 0.1 V Counterclockwise, 0.1 V Counterclockwise, 0.1 V

EXAMPLE: 3.5 MHz — Peak to approximately 3.8 V. Turn slug clockwise for a .5 V decrease to 3.3 V.

- () Turn the FUNCTION switch to STBY.
- () Disconnect the voltmeter test leads and temporarily set them aside.

CRYSTAL CALIBRATOR ALIGNMENT

The crystal calibrator circuit is provided to enable you to accurately calibrate (adjust) your tuning dial every 100 kHz and every 25 kHz. Two methods of accurately adjusting this circuit are given in this section: "Calibration to WWV," and "Calibration Using Another Receiver." The WWV method is preferred.

NOTE: For further information on station WWV, refer to a current copy of "The Radio Amateur's Handbook."

When the FUNCTION switch is in the 100 kHz position, you should be able to hear a harmonic (multiple) of the calibration oscillator at every 100 kHz dial marking. In the 25 kHz position, you should be able to hear a harmonic (multiple) of the calibration oscillator every 25 kHz dial marking.

CALIBRATION TO WWV

- () Connect an antenna to the HF antenna phono socket on the Receiver rear panel.
- () Set the front panel controls and switches to the following positions:

FUNCTION — STBY
 CONVERTER — HF
 PRESELECTOR — Any
 R.F. ATTEN — Fully clockwise
 BAND — 15.0
 MAIN TUNING — 0.00
 AGC — FAST
 RF GAIN — Fully clockwise and pushed in
 MODE — USB
 AF GAIN — 9 o'clock position

- () Turn the FUNCTION switch to OPR.
- () Rotate the PRESELECTOR for maximum noise or signal.
- () Rotate the MAIN TUNING knob back and forth. Station WWV should be heard very close to the "0" mark on the circular dial (within 1 to 3 kHz).
- () Turn the R.F. ATTEN control slowly all the way counterclockwise, then all the way clockwise. Signal strength should diminish, then return to its original loudness.
- () Adjust the MAIN TUNING knob so that the zero-beat tone goes lower and lower in frequency and disappears.
- () Turn the FUNCTION switch to 100 kHz. The tone from the calibrator should be heard. Refer to Figure 11 and adjust 100 kHz ADJ trimmer capacitor C606 on the power supply/BFO circuit board so the calibrator tone goes lower and lower in frequency and disappears. The calibration oscillator is now in zero beat with WWV.
- () Turn the FUNCTION switch to OPR and then back to 100 kHz to be sure you have a true zero beat.

- () When you have a zero beat, turn the FUNCTION switch to STBY.
- () Disconnect the antenna from the Receiver.
- () Turn the BAND switch to 3.5.

CALIBRATION USING ANOTHER RECEIVER

NOTE: Use this calibration procedure if you cannot receive WWV.

- () Set the front panel controls and switches to the following positions:

FUNCTION – STBY
 CONVERTER – HF
 PRESELECTOR – Any
 R.F. ATTEN– Fully clockwise
 BAND – 3.5
 MAIN TUNING – 0.00
 AGC – FAST
 RF GAIN – Fully clockwise and pushed in
 MODE – USB
 AF GAIN – 9 o'clock position

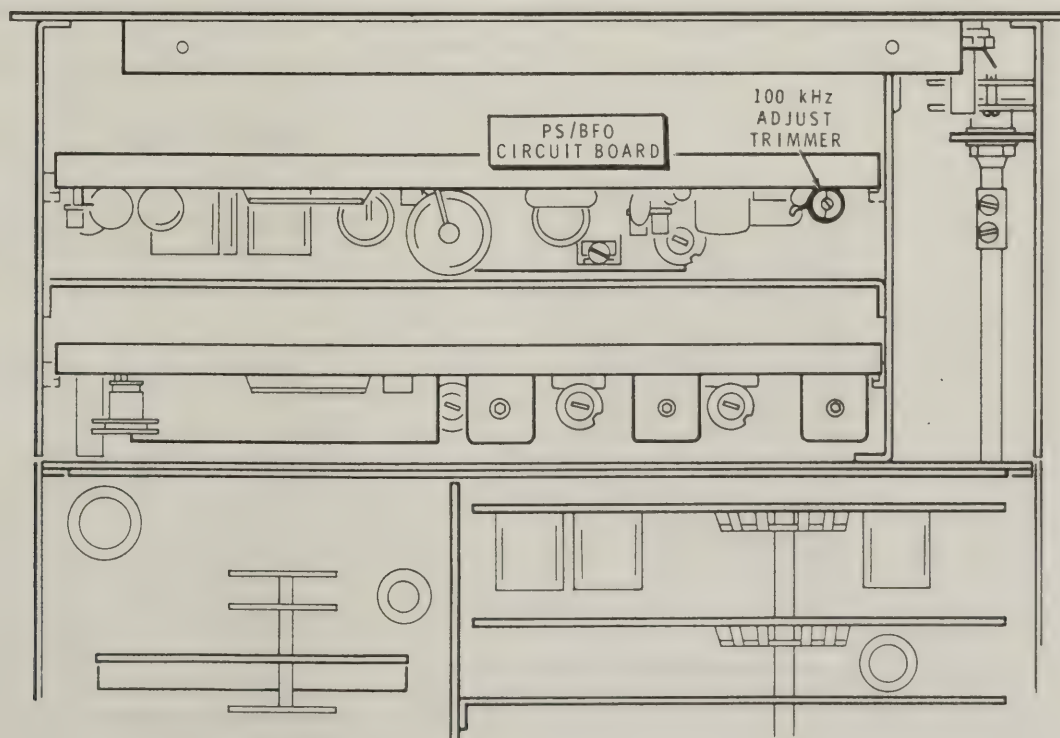


Figure 11

- () Connect the SB-303 Receiver's HF antenna input to an antenna and antenna input of another receiver capable of receiving WWV at 2.5 MHz, 5 MHz, or 10 MHz. If this is not possible, a receiver tuned to a standard broadcast station, operating at an even multiple of 100 kHz or 25 kHz, can be used.
- () Turn the SB-303 Receiver's FUNCTION switch to 100 kHz, and rotate the AF GAIN control fully counterclockwise, just to the point where it starts to click off.
- () Tune the other receiver to WWV or a standard broadcast station as described.
- () Refer to Figure 11 and adjust 100 kHz ADJ trimmer capacitor C606 on the SB-303 power supply/BFO circuit board until you hear the calibrator tone in the other receiver go lower and lower in frequency and disappear. NOTE: When WWV is used, the period when no tone modulation is present allows easier identification of the zero beat.
- () Turn the SB-303 Receiver's FUNCTION switch to OPR and then back to 100 kHz to be sure you have a true zero beat.
- () Turn the SB-303 Receiver's FUNCTION switch to STBY and disconnect the other receiver. The other receiver will no longer be needed.

LMO SHIFTER AND DIAL ADJUSTMENTS

LMO SHIFTER ADJUSTMENT

The purpose of this adjustment is to insure that the LMO remains at zero beat when it is shifted from one sideband to the other.

- () Set the MAIN TUNING to 3.8 MHz.
- () Turn the FUNCTION switch to 100 kHz.
- () Adjust the MAIN TUNING for a loud calibrator tone.
- () Rotate the PRESELECTOR for maximum S-meter reading.
- () Alternately increase the AF GAIN control and adjust the MAIN TUNING until the calibrator tone goes lower and lower in frequency and disappears (zero beat).
- () Rotate the AF GAIN control to a comfortable listening level.
- () Turn the MODE switch to LSB. NOTE: Be very careful not to move the MAIN TUNING.
- () The calibrator tone may or may not be heard. If the tone is not heard, turn the MODE switch back and forth between USB and LSB to be sure the tone is not heard (zero beat) in either switch position. If it is still not heard, proceed to the "Dial Calibration" section. If a tone is heard in either switch position, perform the remaining steps, and then proceed to the "Dial Calibration."

- () Adjust the MAIN TUNING so the tone is not heard in the USB position of the MODE switch. Then turn the MODE switch to LSB.
- () Refer to Figure 12 and adjust the LSB ADJUST coil on the LMO until the tone goes lower and lower in frequency and disappears. NOTE: It may be necessary to increase the AF GAIN control while adjusting the LSB ADJUST coil. This LSB ADJUST coil is adjusted with a small screwdriver through a hole in the RTTY circuit board.

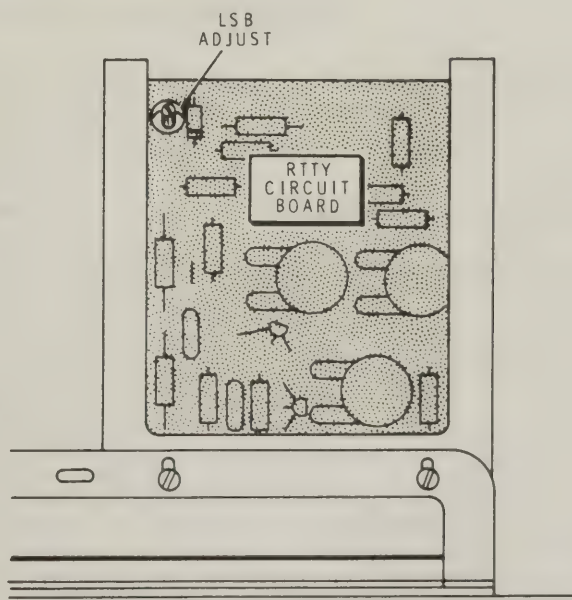


Figure 12

- () Turn the MODE switch back and forth between USB and LSB to be sure the tone is not heard in either switch position. It may be necessary to repeat the previous step if a tone is heard.
- () Rotate the AF GAIN control to the 9 o'clock position.

- () Turn the MODE switch to USB.

DIAL CALIBRATION

- () Remove the knob from the main tuning shaft.
- () Zero beat the calibrator tone at 3.6 MHz.
- () Set the adjustable index line in the center of the circular dial window.

Refer to Figure 13 for the following steps.

- () Wrap the long portion of the long allen wrench with tape to avoid shorting it to the light sockets.
- () Place a screwdriver through the hole in the dial escutcheon (located directly above the main tuning shaft) and into the LMO dial drive shaft.
- () Hold the LMO drive shaft on zero beat and loosen the setscrew in the circular dial bushing. Turn the circular dial until the "0" is directly under the adjustable index line. Now tighten the setscrew.

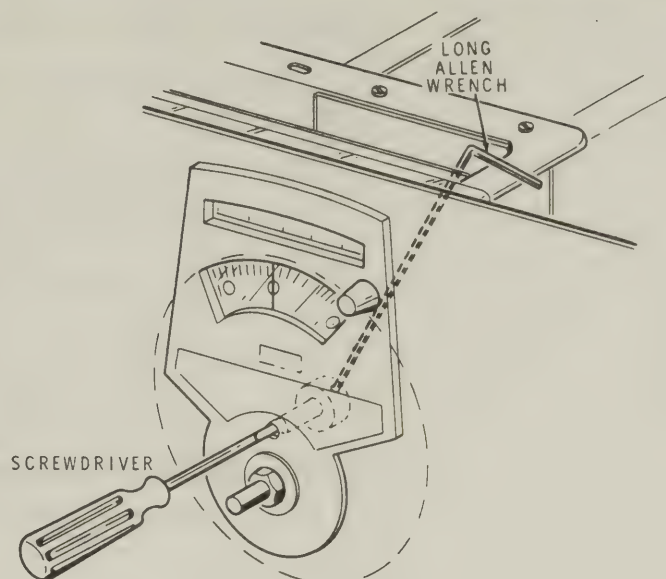


Figure 13

- () Make sure the circular dial turns freely and the nylon spiral follower is properly engaged in the spiral before proceeding. It may be necessary to loosen and retighten the setscrew again.
- () Turn the FUNCTION switch to STBY.
- () Replace the knob on the main tuning shaft.

RF AND IF ALIGNMENT

NOTE: The remaining Receiver alignment can be performed with instruments or without instruments. Instrument alignment requires the use of an ac VTVM and an RF generator that can deliver a signal from 3.5 MHz to 30 MHz. If these instruments are available, proceed to "Instrument Alignment" on Page 121. Otherwise, proceed with "Alignment Without Instruments."

ALIGNMENT WITHOUT INSTRUMENTS

Alignment without instruments is accomplished by using the crystal calibrator as a signal source. No antenna is required.

- () Set the MAIN TUNING to 3.5 MHz.
- () Turn the FUNCTION switch to 100 kHz.
- () AGC to Fast.
- () R.F. ATTN fully clockwise.

Refer to Figure 14 for preselector settings in the following steps. NOTE: The positions shown in the Figure are approximate reference points only.

- () Set the PRESELECTOR to the 3.5 MHz position.
- () Adjust the MAIN TUNING for a maximum S-meter reading.



Figure 14

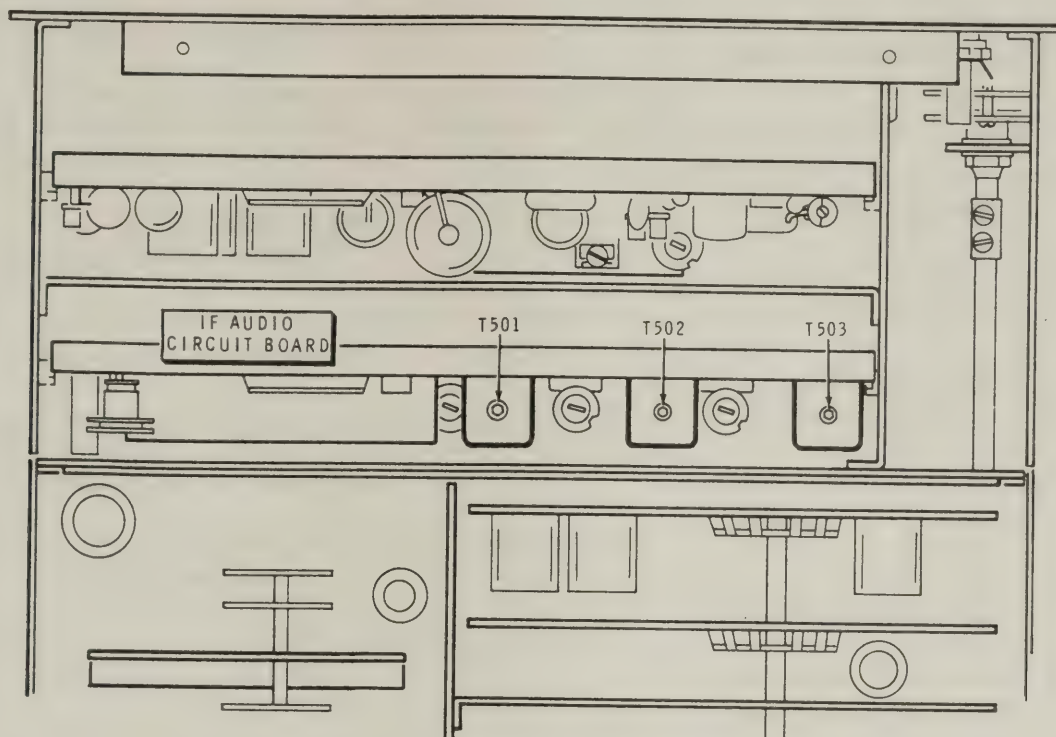


Figure 15

- () Refer to Figure 15 and adjust IF transformers T501, T502, and T503 for a maximum S-meter reading with the large alignment tool.
- () Readjust the three IF transformers for a maximum S-meter reading.
- () Refer to Figure 16 and adjust mixer coil L202 for a maximum S-meter reading.
- () Readjust coil L202 for a maximum S-meter reading.

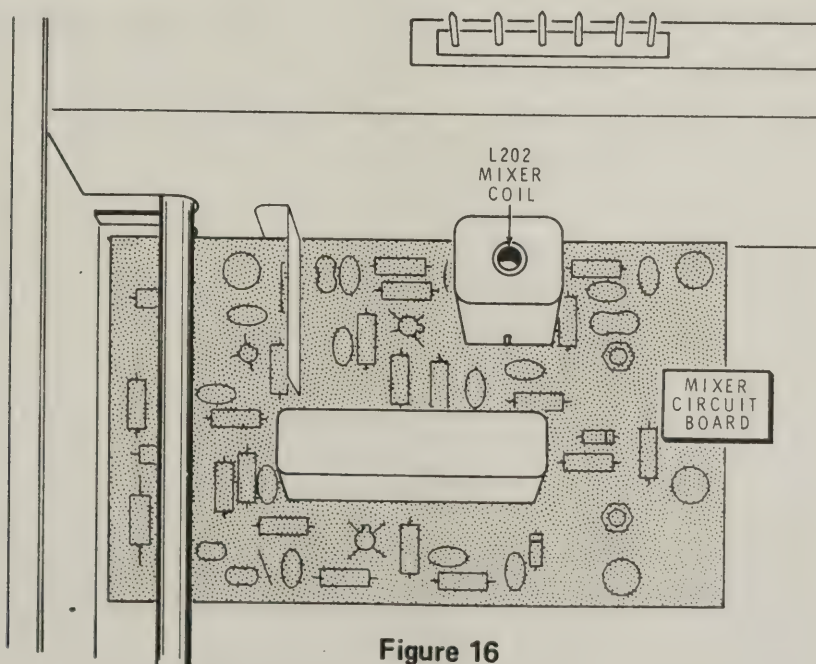


Figure 16

Refer to Figure 17 for the following steps.

NOTE: All antenna coils, referred to in the following steps, are on the antenna Switch-Board and all RF coils are on the RF amplifier Switch-Board. Use the small alignment tool.

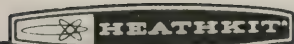
- () Adjust the 3.5 MHz antenna coil, L101, for a maximum S-meter reading.
- () Adjust the 3.5 MHz RF amplifier coil, L108, for a maximum S-meter reading.
- () Set the BAND switch to 7.0, and adjust the MAIN TUNING for a maximum S-meter reading. Leave the PRESELECTOR in the same position.
- () Adjust the 7.0 MHz antenna coil, L102, for a maximum S-meter reading.
- () Adjust the 7.0 MHz RF amplifier coil, L109, for a maximum S-meter reading.
- () Set the BAND switch to 14.0, and adjust the MAIN TUNING for a maximum S-meter reading.
- () Adjust the 14.0 MHz antenna coil, L103, for a maximum S-meter reading.
- () Adjust the 14.0 MHz RF amplifier coil, L111, for a maximum meter reading.
- () Set the BAND switch to 21.0.
- () Set the MAIN TUNING to 21.0 MHz and then adjust the MAIN TUNING for a maximum S-meter reading.
- () Set the PRESELECTOR to 21.0 MHz.
- () Adjust the 21.0 MHz antenna coil, L104, for a maximum S-meter reading.
- () Adjust the 21.0 MHz RF amplifier coil, L112, for a maximum S-meter reading.
- () Set the BAND switch to 29.5, and rotate the MAIN TUNING to 29.9 MHz.
- () Set the PRESELECTOR to the 30.0 MHz reference point.
- () Adjust the 28.0 MHz antenna coil, L105, for a maximum S-meter reading.
- () Adjust the 28.0 MHz RF amplifier coil, L113, for a maximum S-meter reading.
- () Set the FUNCTION switch to STBY.
- () Turn the AF GAIN to PWR. OFF.

This completes "Alignment Without Instruments."

If you have RTTY equipment, proceed with "FSK Alignment" on Page 124. Otherwise, proceed to "Final Assembly" on Page 127.



Figure 17A



3 to 21.0 MHz and then adjust
for a maximum S-meter reading.

R to 21.0 MHz.

z antenna coil, L104, for a
ing.

RF amplifier coil, L112, for a
ing.

to 29.5, and rotate the MAIN

OR to the 30.0 MHz reference

z antenna coil, L105, for a
ing.

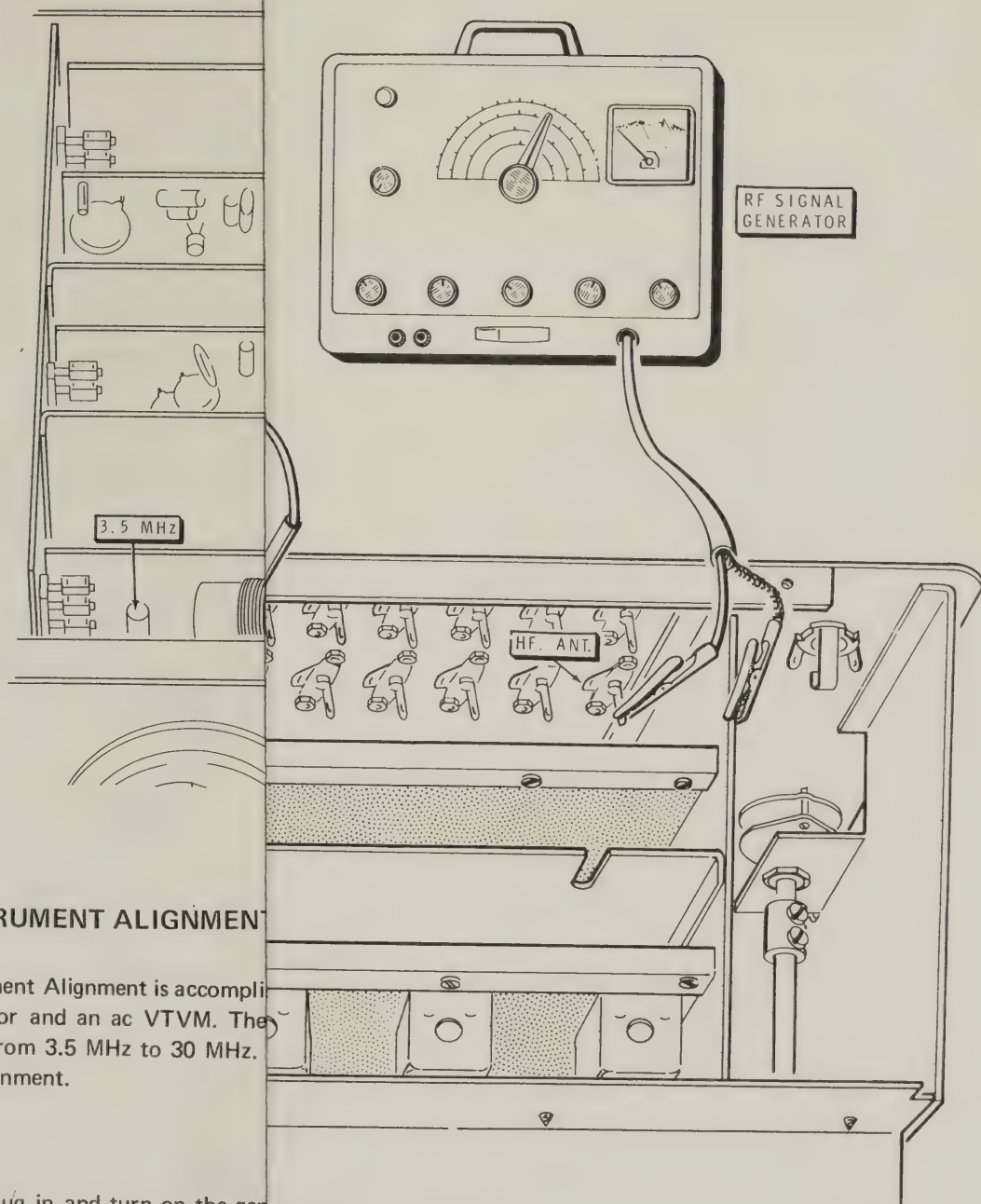
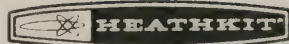
RF amplifier coil, L113, for a
ing.

itch to STBY.

POWER OFF.

Without Instruments."

ipment, proceed with "FSK
Otherwise, proceed to "Final



INSTRUMENT ALIGNMENT

Instrument Alignment is accomplished using an RF signal generator and an ac VTVM. The signal from 3.5 MHz to 30 MHz. this alignment.

- () Plug in and turn on the generator.
Allow both of them time to warm up before proceeding.

FIGURE 18

3 to 21.0 MHz and then adjust
for a maximum S-meter reading.

3 to 21.0 MHz.

z antenna coil, L104, for a
ing.

RF amplifier coil, L112, for a
ing.

to 29.5, and rotate the MAIN

OR to the 30.0 MHz reference

z antenna coil, L105, for a
ing.

RF amplifier-coil, L113, for a
ing.

itch to STBY.

WB OFF.

Without Instruments."

ipment, proceed with "FSK
Otherwise, proceed to "Final

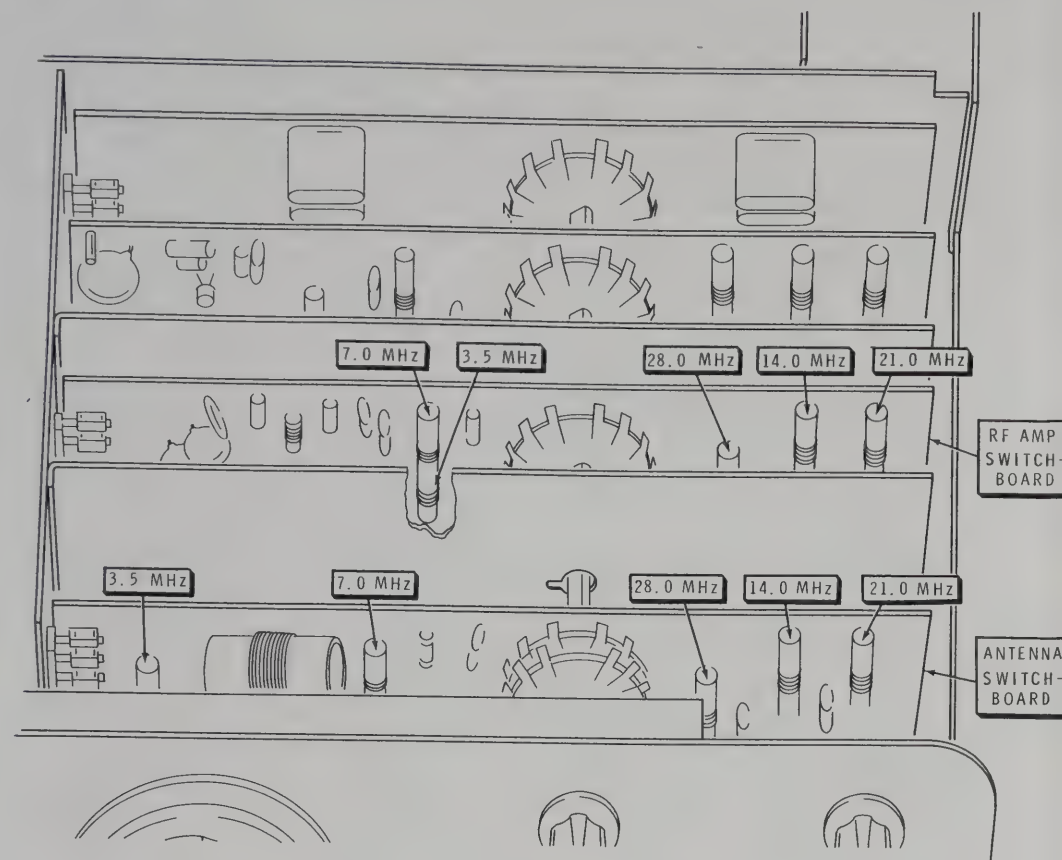


Figure 17

INSTRUMENT ALIGNMENT

Instrument Alignment is accomplished by using an RF signal generator and an ac VTVM. The generator must deliver a signal from 3.5 MHz to 30 MHz. No antenna is required for this alignment.

- () Plug in and turn on the generator and the ac VTVM. Allow both of them time to warm up before proceeding.

Refer to Figure 18 for the following steps.

- () Connect the ac VTVM test leads to the SPEAKER phono socket lugs on the Receiver rear panel.
- () Connect the generator RF output leads to the HF ANT phono socket lugs on the Receiver rear panel.
- () Turn the Receiver FUNCTION switch to OPR.
- () Turn the R.F. ATTEN fully clockwise.
- () Set the MAIN TUNING to exactly 3.5 MHz.

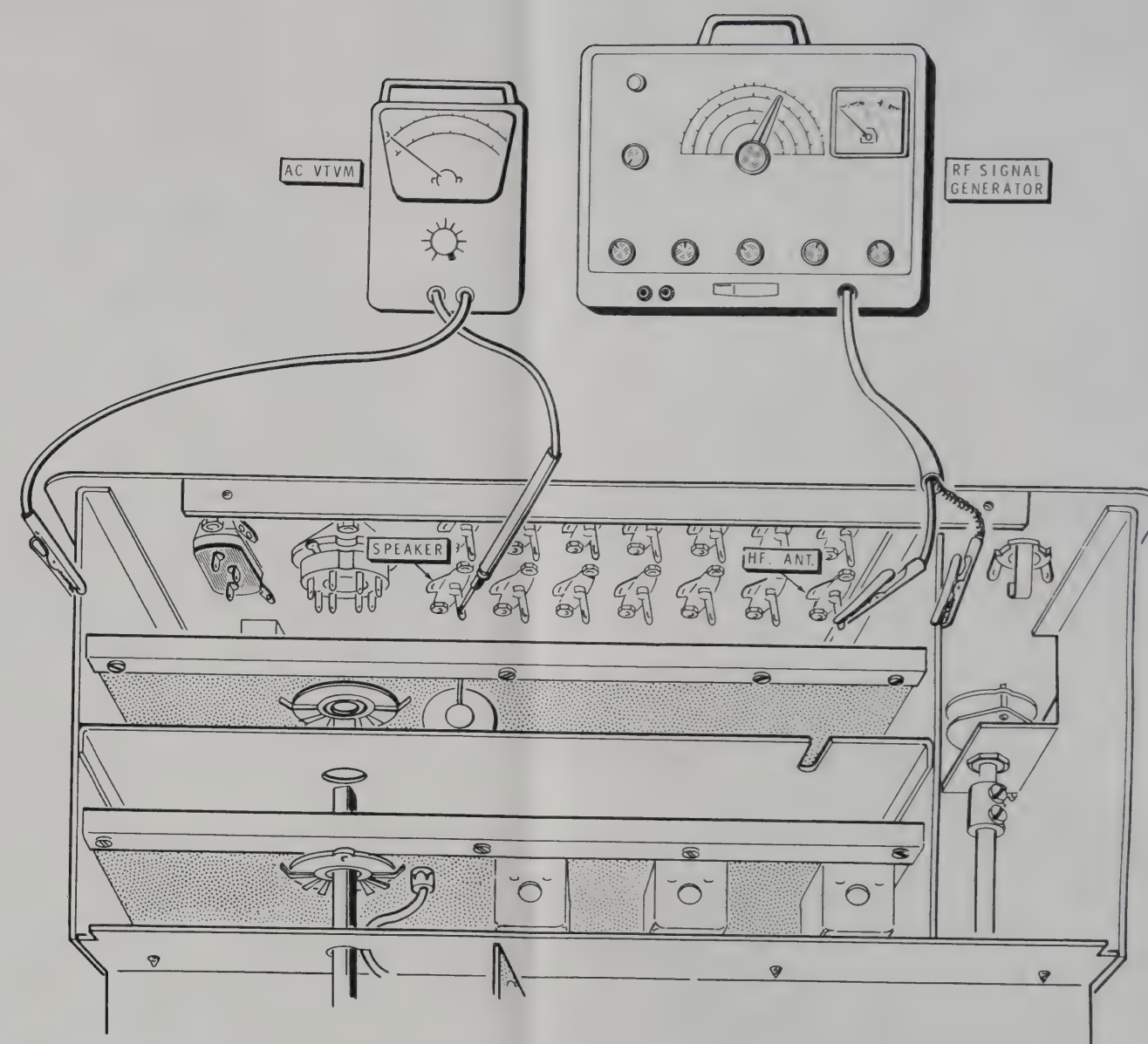


FIGURE 18

PRESELECTOR

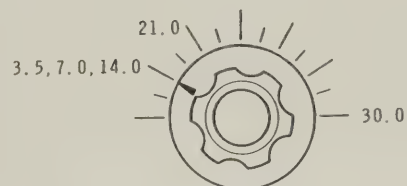
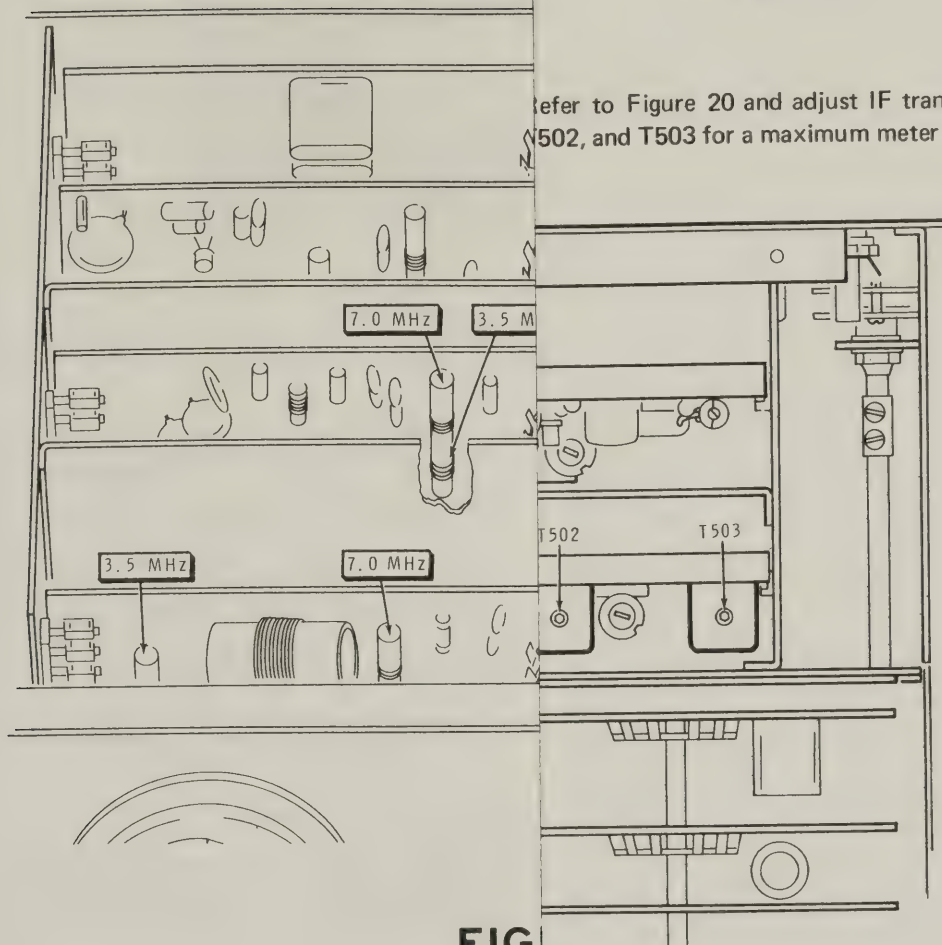


Figure 19

Refer to Figure 20 and adjust IF transformers T501, T502, and T503 for a maximum meter reading.



FIG

- () Refer a max
- () Readju meter r
- () Readju: reading

Refer to Fi
following ste

NOTE: All a
are on the ar
RF amplifier

Perform the
range as requi

Refer to Figure 19 for PRESELECTOR settings in the following steps.

- () Set the PRESELECTOR to the 3.5 MHz reference point.

NOTE: While performing the following steps, adjust the AF GAIN for a comfortable listening level and the ac VTVM range for a midscale meter reading.



Figure 19

- () Tune the RF generator to approximately 3.5 MHz for a maximum ac VTVM meter reading. Decrease the generator amplitude until you have less than an "S-2" S-meter reading.
- () Adjust the voltage range of the ac VTVM for a midscale reading.
- () Refer to Figure 20 and adjust IF transformers T501, T502, and T503 for a maximum meter reading.

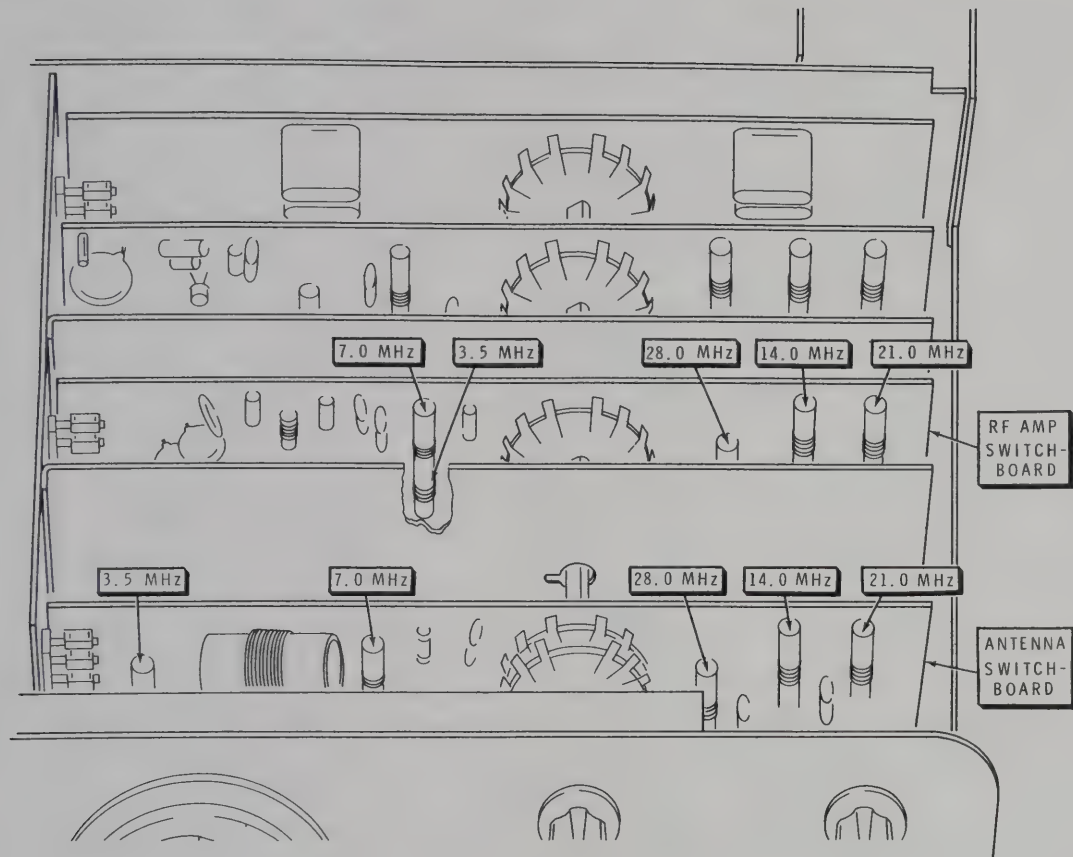


FIGURE 22

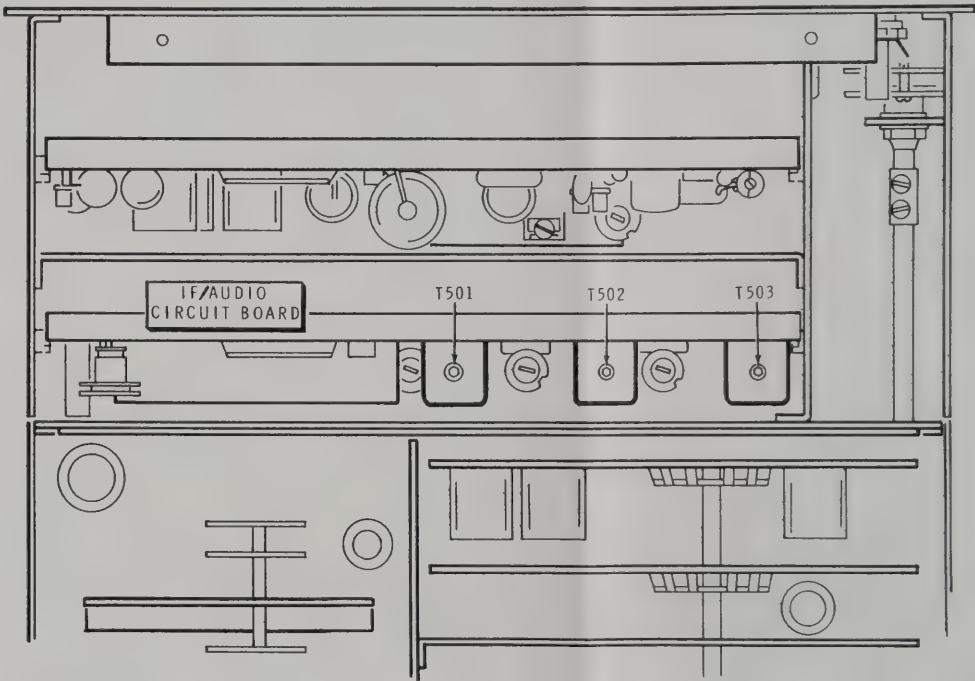


Figure 20

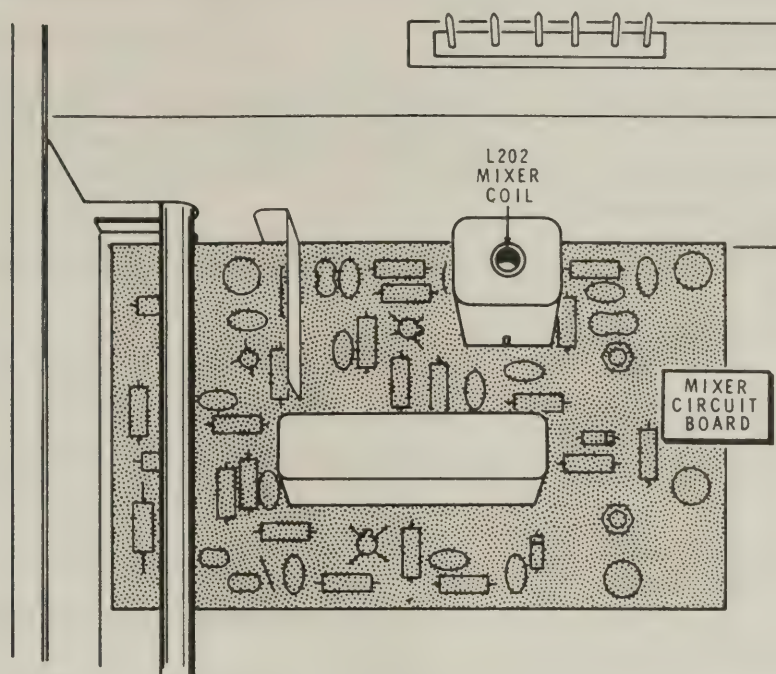


Figure 21

- () Refer to Figure 21 and adjust mixer coil L202 for a maximum meter reading.
- () Readjust the three IF transformers for a maximum meter reading.
- () Readjust mixer coil L202 for a maximum meter reading.
- () Adjust the 3.5 MHz antenna coil, L101, for a maximum meter reading.
- () Adjust the 3.5 MHz RF amplifier coil, L108, for a maximum meter reading.
- () Set the BAND switch to 7.0. Set the PRESELECTOR to the 7.0 MHz reference point.

Refer to Figure 22 (fold-out from Page 122) for the following steps.

NOTE: All antenna coils referred to in the following steps are on the antenna Switch-Board and all RF coils are on the RF amplifier Switch-Board.

Perform the following steps. Change the ac VTVM voltage range as required.

- () Tune the generator to approximately 7.0 MHz for a maximum VTVM reading. Then decrease the generator amplitude until you have less than an "S-2" S-meter reading.
- () Adjust the 7.0 MHz antenna coil, L102, for a maximum meter reading.
- () Adjust the 7.0 MHz RF amplifier coil, L109, for a maximum meter reading.

- () Set the BAND switch to 14.0
 - () Tune the generator to approximately 14.0 MHz for maximum VTVM reading. Then decrease the generator amplitude until you have less than an "S-2" S-meter reading.
 - () Set the PRESELECTOR to the 14.0 MHz reference point.
 - () Adjust the 14.0 MHz antenna coil, L103, for a maximum meter reading.
 - () Adjust the 14.0 MHz RF amplifier coil, L111, for a maximum meter reading.
 - () Set the BAND switch to 21.0.
 - () Set the MAIN TUNING to 21.00 MHz.
 - () Tune the generator to approximately 21.0 MHz for maximum VTVM reading. Then decrease the generator amplitude until you have less than an "S-2" S-meter reading.
 - () Set the PRESELECTOR to the 21.0 MHz reference point.
 - () Adjust the 21.0 MHz antenna coil, L104, for a maximum meter reading.
 - () Adjust the 21.0 MHz RF amplifier coil, L112, for a maximum meter reading.
 - () Set the BAND switch to 29.5.
 - () Set the MAIN TUNING to 29.9 MHz.
 - () Tune the generator to approximately 30.0 MHz for maximum VTVM reading. Then decrease the generator amplitude until you have less than an "S-2" S-meter reading.
 - () Set the PRESELECTOR to the 30.0 MHz reference point.
 - () Adjust the 28.0 MHz antenna coil, L105, for a maximum meter reading.
 - () Adjust the 28.0 MHz RF amplifier coil, L113, for a maximum meter reading.
 - () Set the FUNCTION switch to STBY.
 - () Turn the AF GAIN to PWR OFF.
- This completes the "Instrument Alignment."
- () Disconnect the ac VTVM test leads and the RF generator test leads from the Receiver.
- If you have RTTY equipment, proceed with "FSK Alignment." Otherwise, proceed to "Final Assembly" on Page 127.

FSK ALIGNMENT

The FSK alignment uses an 850 Hz wide frequency shift, a 170 Hz narrow frequency shift, and a 50 Hz CW frequency shift. This same procedure can be used for FSK alignment using shift frequencies other than those stated.

PRESETTING CONTROLS

- () Set the front panel controls and switches to the following positions:

FUNCTION – STBY
 CONVERTER – HF
 PRESELECTOR – Any
 R.F. ATTN – Fully clockwise
 BAND – 3.5
 MAIN TUNING – 3.6
 AGC – FAST
 RF GAIN – Fully clockwise and pushed in
 MODE – RTTY
 AF GAIN – 9 o'clock position

NOTE: The FSK alignment can be performed using an electronic counter or audio frequency meter, or a terminal unit and oscilloscope. If an electronic counter or audio frequency meter is available, proceed with "FSK Instrument Alignment." Otherwise, proceed with "FSK Terminal Unit Alignment."

FSK INSTRUMENT ALIGNMENT

- () Connect an electronic counter or frequency meter to the SPEAKER phono socket.

CAUTION: 120 Vac or 240 Vac is present at the ac power socket and circuit breaker on the Receiver rear panel. Therefore, be very careful when installing and removing jumper wires in the following steps.

- () Install a jumper wire from WIDE SHIFT lug 1 on the Accessory socket to chassis ground.
- () Install a jumper wire from NARROW SHIFT lug 5 on the Accessory socket to chassis ground.
- () Turn the FUNCTION switch to 100 kHz.
- () Rotate the PRESELECTOR for a maximum S-meter reading.
- () Adjust the MAIN TUNING for a 2975 Hz reading on the electronic counter or frequency meter.
- () Remove the WIDE SHIFT jumper from the Accessory Socket.
- () Adjust WIDE control R317 on the RTTY circuit board for a 2125 Hz reading.
- () Replace the WIDE SHIFT jumper on the Accessory Socket.

NOTE: The electronic counter or frequency meter should again read 2975 Hz. If this reading is not obtained, repeat the four previous steps.

- () Adjust the MAIN TUNING for a 2975 Hz reading.
- () Remove the NARROW SHIFT jumper from the Accessory Socket.
- () Adjust NARROW control R313 on the RTTY circuit board for a 2805 Hz reading.
- () Replace the NARROW SHIFT jumper on the Accessory Socket.

NOTE: The electronic counter or frequency meter should again read 2975 Hz. If this reading is not obtained, repeat the four previous steps.

- () Adjust the MAIN TUNING for a 2975 Hz reading.
- () Install a jumper wire from CW SHIFT lug 7 on the Accessory Socket to chassis ground.
- () Adjust CW control R308 on the RTTY circuit board for a 2925 Hz reading.
- () Remove the CW SHIFT jumper wire from the Accessory Socket.

NOTE: The electronic counter or the frequency meter should again read 2975 Hz. If this reading is not obtained, repeat the four previous steps.

- () Turn the FUNCTION switch to STBY.
- () Remove the WIDE SHIFT jumper wire from the Accessory Socket.
- () Remove the NARROW SHIFT jumper wire from the Accessory Socket.

This completes the "FSK Alignment."

Proceed to "Final Assembly" on Page 127.

FSK ALIGNMENT WITH TERMINAL UNIT

- () Connect your terminal unit audio input to the Receiver's ANTI-VOX phono socket. Set the terminal unit for wide shift.

CAUTION: 120 Vac or 240 Vac is present at the ac power socket and circuit breaker on the Receiver rear panel; therefore, be very careful when installing and removing jumper wires in the following steps.

- () Install a jumper wire from WIDE SHIFT lug 1 on the Accessory Socket to chassis ground.
- () Install a jumper wire from NARROW SHIFT lug 5 on the Accessory Socket to chassis ground.
- () Turn the FUNCTION switch to 100 kHz.
- () Adjust the MAIN TUNING for a space ellipse on the oscilloscope.
- () Remove the WIDE SHIFT jumper from the Accessory Socket.
- () Adjust WIDE control R317 on the RTTY circuit board for an 850 Hz frequency shift (mark ellipse at 2125 Hz) on the oscilloscope.
- () Replace the WIDE SHIFT jumper on the Accessory Socket.

NOTE: The oscilloscope should again display a space ellipse. If this display is not obtained, repeat the four previous steps.

- () Adjust the terminal unit for a narrow shift.
- () Adjust the MAIN TUNING for a space ellipse (2295 Hz) on the oscilloscope.
- () Remove the NARROW SHIFT jumper from the Accessory Socket.

- () Adjust NARROW control R313 on the RTTY circuit board for a 170 Hz frequency shift (mark ellipse at 2125 Hz) on the oscilloscope.

- () Replace the NARROW SHIFT jumper on the Accessory Socket.

NOTE: The oscilloscope should again display a space ellipse. If this display is not obtained, repeat the four previous steps.

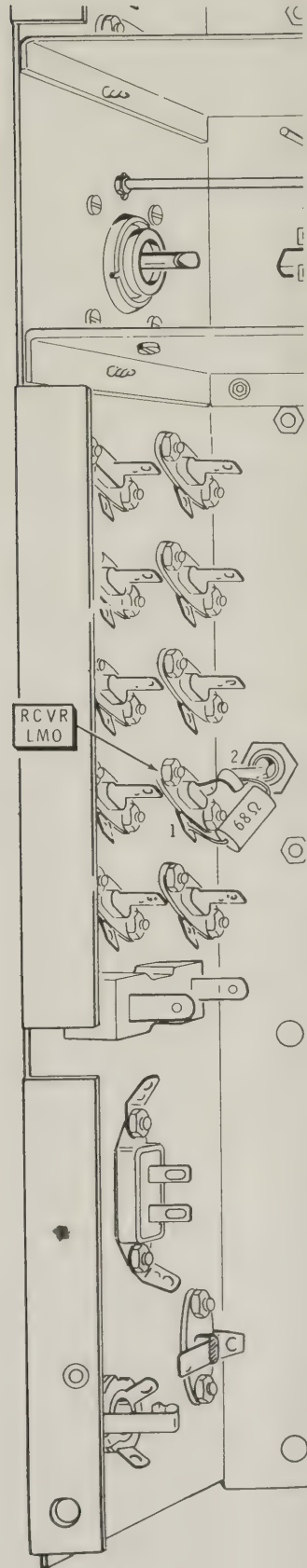
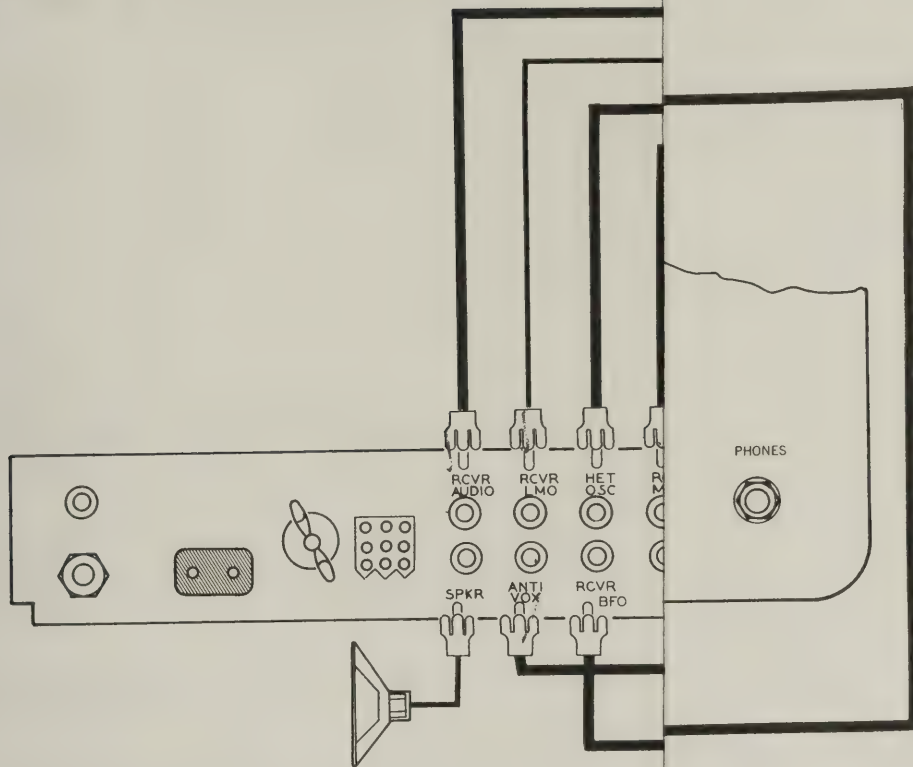
- () Adjust the MAIN TUNING for a space ellipse on the oscilloscope.
- () Install a jumper wire from CW SHIFT lug 7 on the Accessory Socket to chassis ground.
- () Adjust CW control R308 on the RTTY circuit board for an approximate 50 Hz frequency shift on the oscilloscope.
- () Remove the CW SHIFT jumper wire from the Accessory Socket.

NOTE: The oscilloscope should again display a space ellipse. If this display is not obtained, repeat the four previous steps.

- () Turn the FUNCTION switch to STBY.
- () Remove the WIDE SHIFT jumper wire from the Accessory Socket.
- () Remove the NARROW SHIFT jumper wire from the Accessory Socket.

This completes the "FSK Alignment."

Proceed to "Final Assembly."



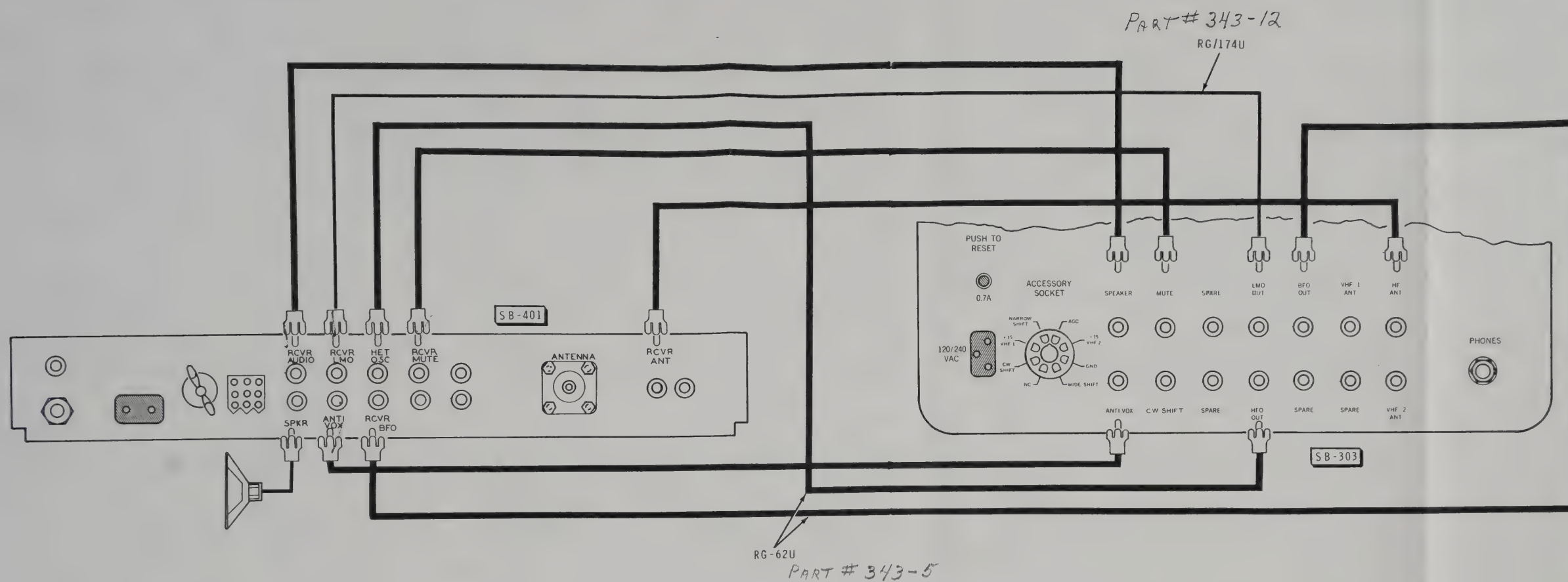
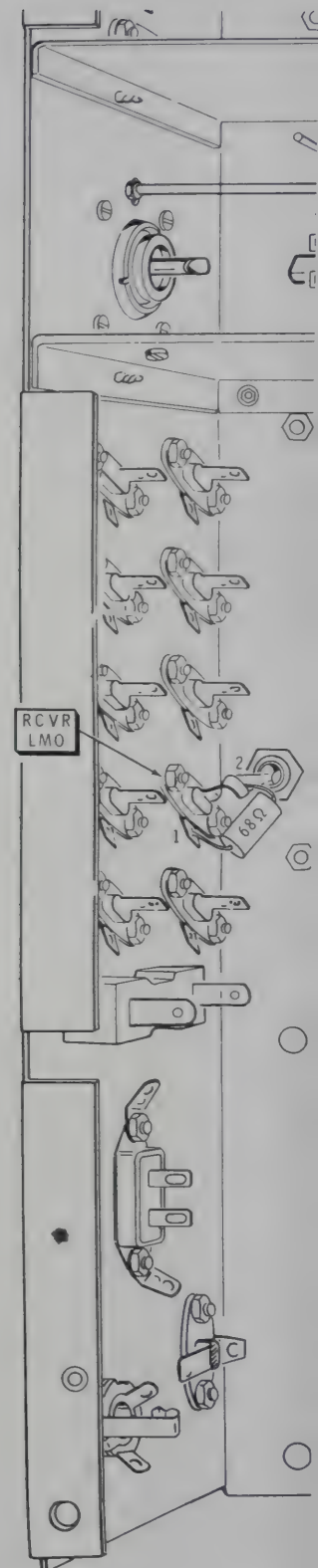


FIGURE 27



INSTALLATION

Although the Receiver operates well over a considerably wide temperature range, it will operate best with adequate air circulation.

To operate the Receiver with either the SB-400 or SB-401, complete one of the following transmitter modifications, depending on which transmitter you intend to use.

SB-400 MODIFICATION

- () Unplug the line cord and disconnect all cables from your transmitter rear panel.
- () Remove the transmitter from its cabinet.
- () Locate the RCVR LMO phono socket on the rear panel. Refer to Figure 23 and connect a 68 Ω (blue-gray-black) resistor from lug 1 to lug 2. Solder both connections.
- () Replace the cabinet, reconnect cables, and plug in the line cord.

Proceed to "Rear Panel Connections."

SB-401 MODIFICATION

Refer to Figure 24 for the following steps.

- () Unplug the line cord and disconnect all cables from your transmitter rear panel.
- () Remove the transmitter from its cabinet.
- () Locate the 100 Ω (brown-black-brown) resistor on the front panel Frequency Control switch.
- () Remove and discard this resistor.
- () Connect a 68 Ω (blue-gray-black) resistor from lug 6 of the switch to the control solder lug. Solder both connections. Be sure the lead does not touch the switch spacer.
- () Connect a 68 Ω (blue-gray-black) resistor from lug 4 of the switch to the control solder lug. Solder both connections.

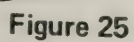


Figure 25

LMO OUT — The LMO operating frequency is present at this socket for connection to the companion transmitter for transceive operation. Use the RG-174/U coaxial cable supplied. The LMO load must be connected to this socket when the transmitter is disconnected. (47 Ω)

HFO OUT — The heterodyne oscillator output is available at this socket for connection to the companion transmitter for transceive operation. Use the RG-62/U coaxial cable supplied.

BFO OUT — The BFO output signal is present at this socket for connection to the companion transmitter for transceive operation. Use the RG-62/U coaxial cable supplied.

CW SHIFT — This socket provides for connection of a key for CW identification when operating RTTY equipment.

ACCESSORY SOCKET — B+ (regulated +15 Vdc at 25 mA maximum) voltages are present at this socket for operating a VHF converter. This voltage is applied to the appropriate converter by the CONVERTER switch. An AGC voltage is also available for connection to converters for gain control. The AGC voltage will range from +3.5 Vdc with no signal to -8.0 Vdc under muted conditions. The converter's AGC input should have a dc resistance greater than 10 M Ω . Wide shift, narrow shift, and CW shift connections function only when the MODE switch is in the RTTY position. Disregard these connections if you do not plan to operate RTTY equipment.

SPARE — There are four spare sockets for interconnection of accessory equipment.

OPERATION

Refer to Figure 28 for the location and complete explanation of the front panel controls.

The following steps apply to all five modes of operation. However, if either or both optional crystal filters (CW or AM) are not installed, switch to the USB or LSB mode. For satisfactory AM reception in USB or LSB mode, zero beat the AM carrier.

Complete the following steps.

1. Preset the controls as follows:

FUNCTION – STBY

CONVERTER – HF (unless using converter)

PRESELECTOR – 12 o'clock

R.F. ATTN – Fully clockwise

BAND – As desired

AGC – Fast

RF GAIN – Full clockwise

SPEAKER DISABLE – In for speaker and phones, out for phones

MODE – As required (NOTE: Calibrate in the USB mode; then switch to the desired mode. When operating in the CW mode, it may be easier to tune in the USB mode.)

AF GAIN – 9 o'clock

MAIN TUNING – As desired

NOTE: The following settings compensate for any heterodyne oscillator frequency variation from the exact frequency marked on the crystal.

2. Turn the FUNCTION switch to 25 kHz (use 100 kHz if the desired frequency is nearest an even 100 kHz) to obtain a calibrator signal.
3. Zero beat the Receiver to the calibrator signal.
4. Use the ZERO SET knob to place the zero set line directly over the 0, 25, 50, or 75 on the tuning dial.
5. Peak the PRESELECTOR for maximum S-meter reading.
6. Turn the FUNCTION switch to OPR.
7. Tune for a desired signal (except RTTY mode) while adjusting the AF GAIN control for the desired audio level. NOTE: In the RTTY mode, tune across the desired signal until both audio signals are balanced at the input of the terminal unit.

FUNCTION

Turns the Receiver from Standby to Operate, manual muting of the Receiver during transmission, turns on the 100 kHz or 25 kHz crystal calibration.

S METER

Indicates received signal strength.

PRESELECTOR

Tunes the RF amplifier stages. Must be readjusted each BAND as main tuning is changed.

AGC

Selects FAST or SLOW AGC circuit time constant; or turns OFF the AGC.

CONVERTER

Selects the proper antenna input and applies power to the rear panel Accessory Socket.



R.F. GAIN

Controls gain of RF and IF amplifiers. The push-pull SPEAKER DISABLE switch disconnects the speaker for phones operation.

R.F. ATTN

Prevents overloading receiver with strong signals.

A.F. GAIN

Controls the audio output level and turns on the power.

BAND

Selects one of: five bands, four segments on the meter band; or WWV.

MODE

Selects the type of detection and crystal filter; turns off the BFO at AM position. (AM and CW positions are used only when optional filters are installed.)

compensate for any variation from the exact

to 25 kHz (use 100 kHz arrest an even 100 kHz) to

calibrator signal.

place the zero set line 75 on the tuning dial.

for maximum S-meter

to OPR.

cept RTTY mode) while
ol for the desired audio
mode, tune across the
o signals are balanced at

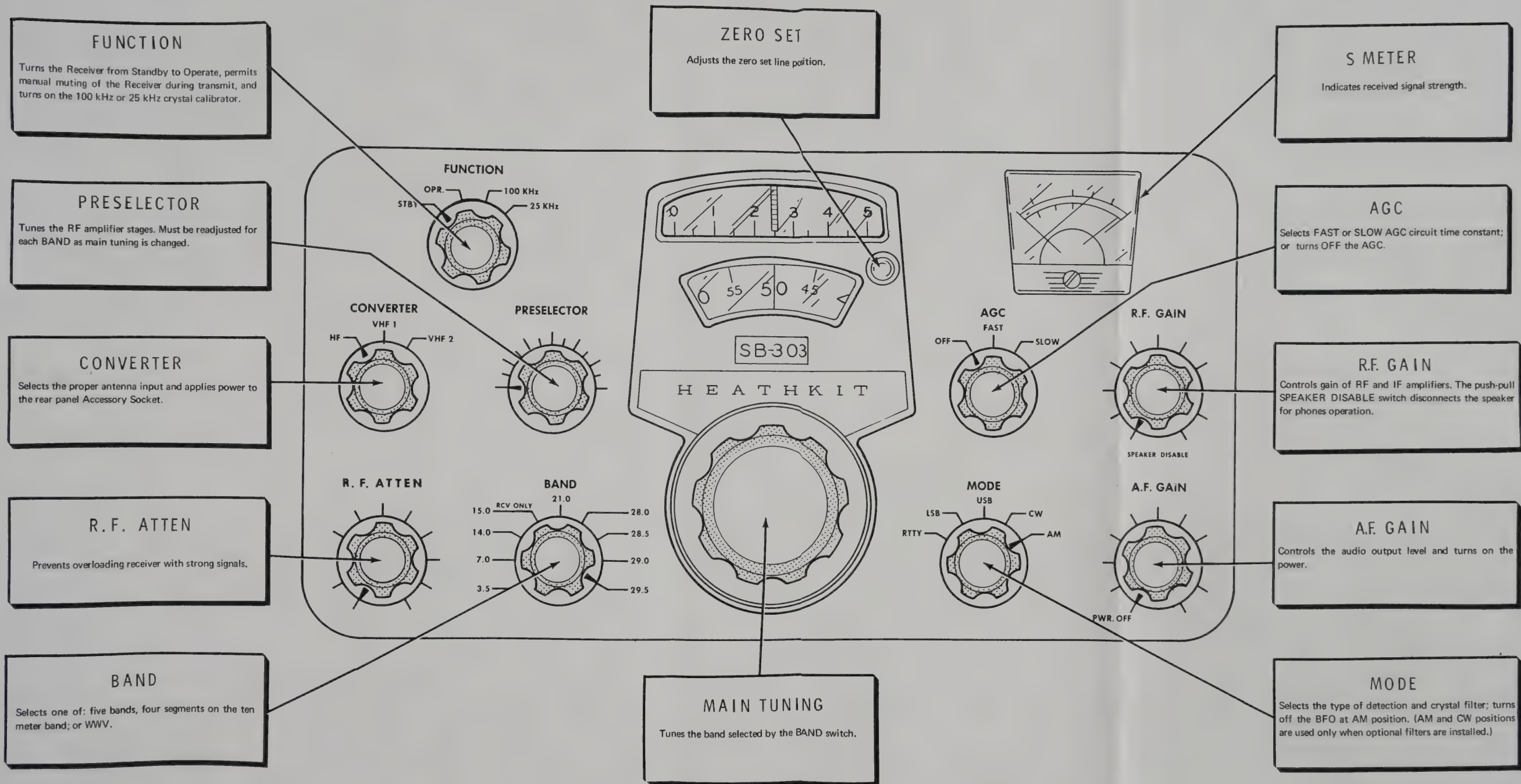


FIGURE 28

IN CASE OF DIFFICULTY

INTRODUCTION

This part of the Manual is intended to provide you with information that will help you locate and correct any difficulty which might occur in your Receiver. This information is divided into four sections. The first section contains suggestions of a general nature in the following areas:

- A. Visual checks and inspection.
- B. Precautions to observe when bench testing.
- C. How to determine the area of the Receiver in which the trouble is located (How to Troubleshoot Your Receiver).
- D. Locating and correcting both the cause and the effect of a trouble (Repairing the Receiver).

The second section contains information on how to install and use extender boards. An extender board can be used to extend a circuit board out of the chassis for troubleshooting.

The third section consists of troubleshooting charts. These charts call out specific problems that may occur and list one or more conditions or components that could cause each difficulty. The resistor R numbers, capacitor C numbers, coil L numbers, transformer T numbers, and the test point numbers, are identified in these charts by the same numbers that are used on the circuit board diagrams and the Schematic Diagram. X-ray views are also provided to help you locate the components and test points.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is inside the front cover.

GENERAL

VISUAL CHECKS

1. About 90% of the kits that are returned for repair, do not function properly due to poor soldering. Therefore, many troubles can be eliminated by a careful inspection of connections to make sure they are soldered as described in the Soldering section of the "Kit Builders Guide." Reheat any doubtful connections and be sure all the wires are soldered at places where several wires are connected. Check carefully for solder bridges between circuit board foils.
2. Check to be sure that all transistors are in their proper locations, and are installed correctly.
3. Check the value of each part. Be sure that the proper part has been wired into the circuit, as shown in the

Pictorial diagrams and as called out in the wiring instructions. It would be easy, for example, to install a 2200 Ω (red-red-red) resistor in a step that calls for a 220 Ω (red-red-brown) resistor.

4. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you have consistently overlooked.
5. Check all component leads connected to the circuit boards. Make sure the leads do not extend through the circuit board and make contact with other connections or parts, such as shields or the chassis.

6. Check all of the wires that are connected to the Switch-Board and circuit board plugs to be sure the wires do not touch the chassis or other lugs. Make sure all wires are properly soldered.
7. If the difficulty still is not cured, read the "Precautions for Bench Testing" section, and the section titled "How to Troubleshoot Your Receiver."

PRECAUTIONS FOR BENCH TESTING

NOTE: Use an 11 megohm input impedance VTVM for voltage measurements.

1. Be cautious when testing transistor circuits. Although transistors have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than tubes.
2. Be sure you do not short any terminals to ground when making voltage measurements. If the probe should slip, for example, and short out a bias or voltage supply point, it is almost certain to cause damage to one or more transistors or diodes.
3. Do not remove components while the Receiver is turned on, since this could damage the Receiver.
4. Do not remove Switch-Boards or circuit boards while the Receiver is turned on.

5. The Receiver can be turned on after a Switch-Board or circuit board is removed.

CAUTION: The full ac line voltage is present at several points (circuit breaker, ac socket, PWR Off/On switch, etc.) in the power supply circuit of the Receiver. Be careful to avoid personal shock when performing the checks described.

HOW TO TROUBLESHOOT YOUR RECEIVER

Go directly to the Troubleshooting Charts to see if the difficulty you are having is listed in one of the "Symptom" columns. If your difficulty is listed there, check the "Possible Causes" listed for that item and apply the Visual Checks listed to the Area of Difficulty.

REPAIRING THE RECEIVER

When you make repairs to your Receiver, make sure you eliminate the cause as well as the effect of the trouble. If, for example, you should find a damaged resistor, be sure you find out what (wiring error, etc.) caused the resistor to become damaged. If the cause is not eliminated, the replacement resistor may also become damaged when the Receiver is put back into operation.

EXTENDER BOARDS

Two extender boards are supplied with this Kit. These boards provide a means of extending a Switch-Board or circuit board out of the chassis for making voltage or resistance measurements. The small extender board is used with the antenna, heterodyne oscillator, RF Amplifier, and crystal Switch-Boards. The large extender board is used with the IF/audio and power supply/BFO circuit boards. For installation instructions, refer to the following information under the appropriate heading.

CAUTION: Disconnect the line cord before extending a Switch-Board or circuit board. Reconnect the line cord while the board is extended, or after it is reinstalled.

SMALL EXTENDER BOARD INSTALLATION

Refer to Figure 29 for the following steps.

1. Position the Receiver up-side-down with the front panel toward you.
2. Loosen the band switch shaft collar. Then slide the band switch shaft out far enough to clear the Switch-Board you wish to extend.
3. Disconnect any coaxial cables or wires connected to the Switch-Board. Coaxial cables and wires must remain disconnected throughout extended board operation.
4. Remove the Switch-Board from the Receiver by sliding it away from the plug board.
5. Install the small extender board into the Receiver in place of the switch board with the foil side facing the rear of the Receiver.
6. Connect the Switch-Board to the end of the small extender board.

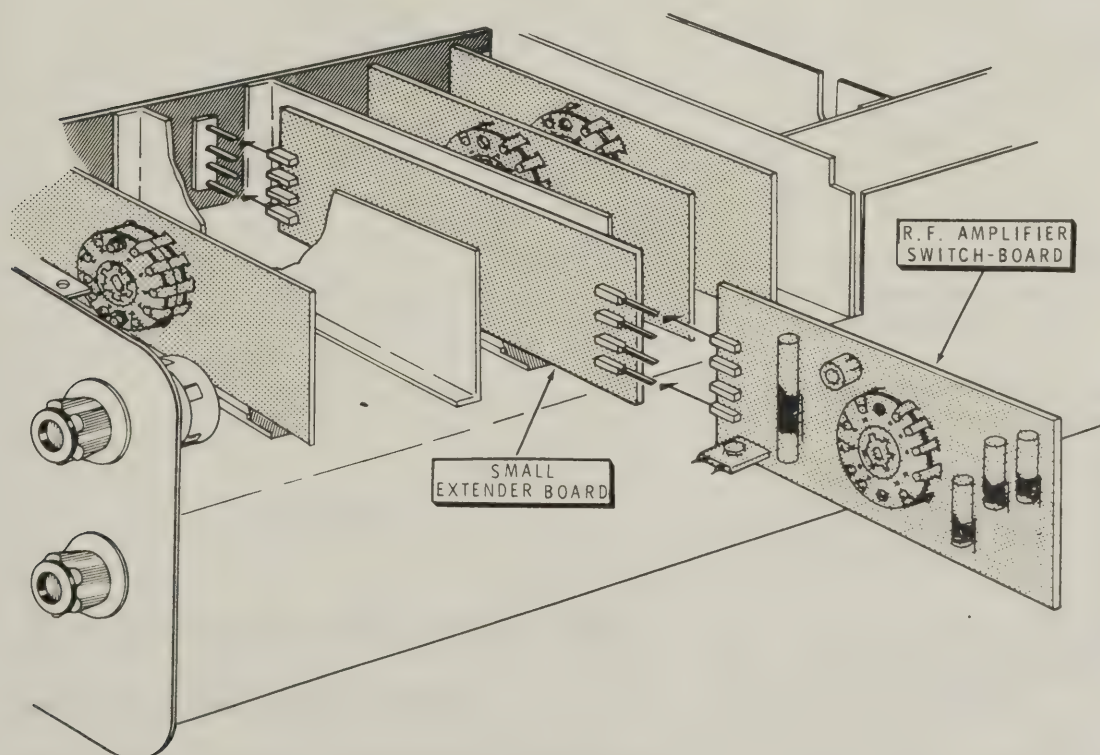


Figure 29

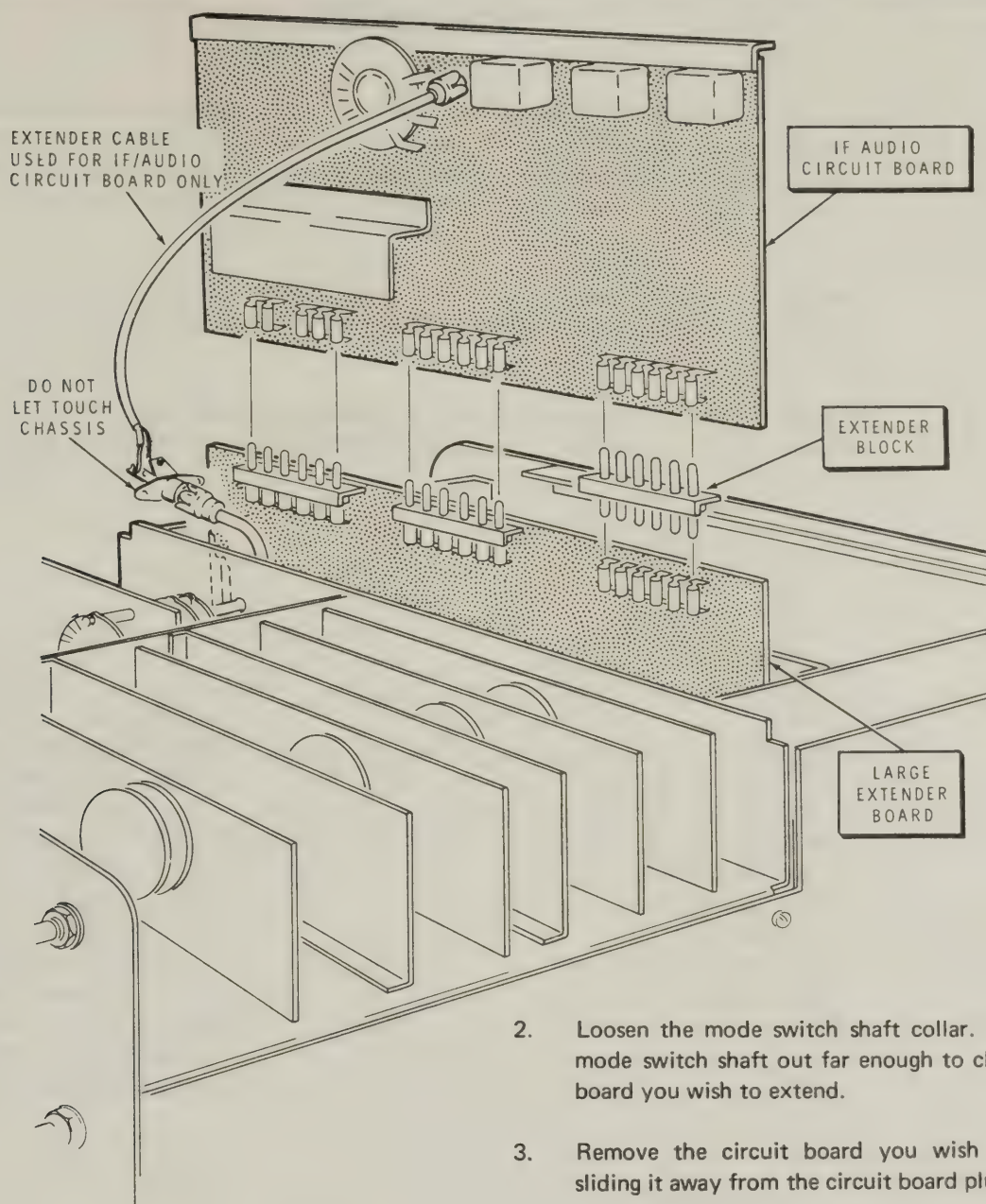


Figure 30

LARGE EXTENDER BOARD INSTALLATION

Refer to Figure 30 for the following steps.

NOTE: Either the IF/audio or the power supply/BFO circuit board can remain fully operational when extended.

1. Position the Receiver up-side-down with the front panel toward you.
2. Loosen the mode switch shaft collar. Then slide the mode switch shaft out far enough to clear the circuit board you wish to extend.
3. Remove the circuit board you wish to extend by sliding it away from the circuit board plugs.
4. The coaxial cables can remain connected throughout extended board operation. Use the extender cable for the IF IN coaxial cable when extending the IF/audio circuit board.
5. Install the large extender board into the Receiver in place of the circuit board with the foil side facing the rear of the Receiver.
6. Insert a 6-pin extender block into each group of circuit board connectors on the circuit board.
7. Install the extender board on the 6-pin extender blocks on the circuit board.

TROUBLESHOOTING

The Troubleshooting Charts on these pages list specific difficulties that could occur in your Receiver. Several possible causes may be listed for each difficulty. The chassis has its own Troubleshooting Chart and Chassis Photographs. The chassis Troubleshooting Chart may direct you to a Switch-Board or circuit board troubleshooting chart if the cause of the trouble is not on the chassis.

Each Switch-Board and circuit board troubleshooting section has its own troubleshooting chart, X-ray views, resistance views, voltage views, and schematic. Refer to these to locate and identify parts listed in the charts.

NOTE: The following index lists the symptoms found in all of the troubleshooting charts. The page number or numbers after each symptom indicates pages on which the symptom and its possible causes will be found.

INDEX

Pilot lamps fail to light	140
No audio output	140 and 156
No IF output	140 and 156
No output from crystal filters	140
No output from the second mixer	140-152
No output from the first mixer	140-152
HFO does not operate	141, 148, 150, and 152
No output from the RF amplifier	141, 144, 146, and 156
AGC does not operate	141, 146, and 156
S meter does not operate	141, 146, and 156
Calibrator does not operate	141 and 158
RTTY does not operate	141 and 154
BFO does not operate	156 and 158
Product detector does not operate	156
AM detector does not operate	156
Power supply voltages incorrect	158

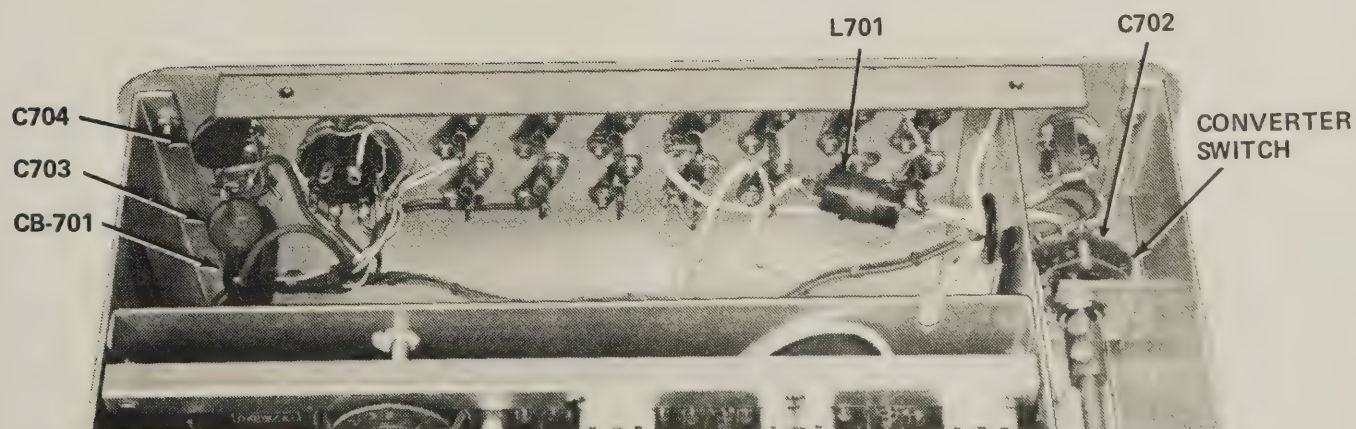
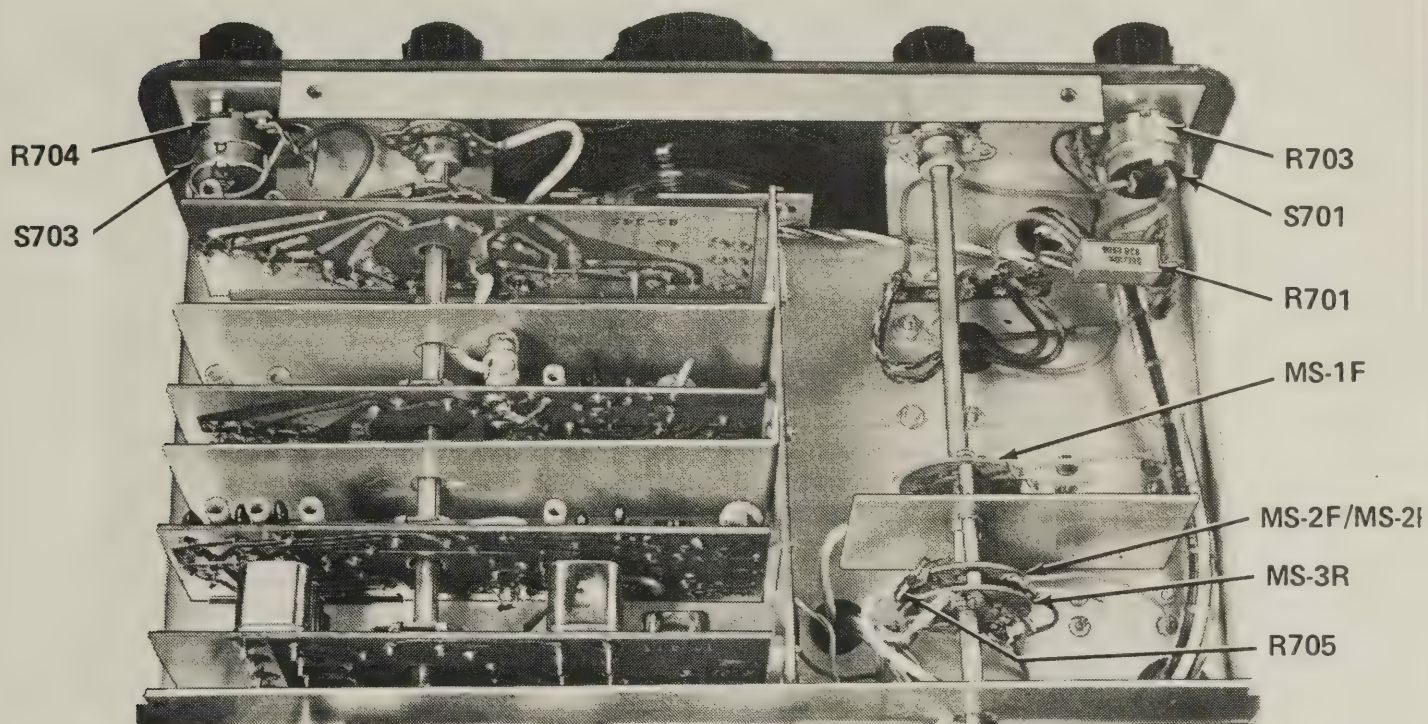
CHASSIS

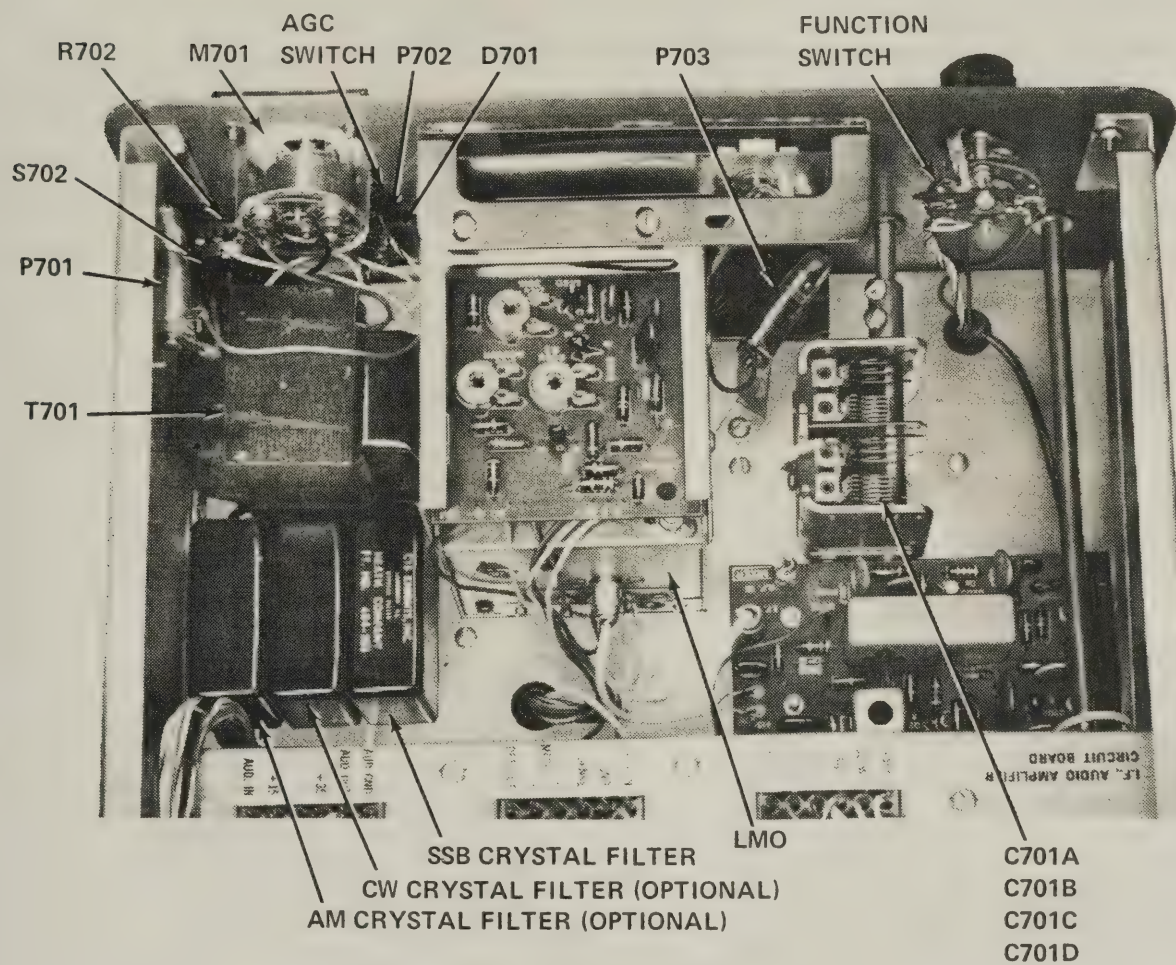
TROUBLESHOOTING CHART (Also see "Chassis Photographs," Pages 142, 143.)

SYMPTOM	POSSIBLE CAUSE
Pilot lamps fail to light.	1. Circuit breaker open. 2. Capacitor C703 or C704. 3. PWR switch wired incorrectly or open. 4. Pilot lamps P701, P702, or P703 open (lamps are wired in series). 5. 5-lug terminal strip AY and/or 3-lug terminal strip AZ wired incorrectly.
No audio output.	1. Speaker not properly connected. 2. SPEAKER DISABLE switch pulled out. 3. AF GAIN control incorrectly wired or open. 4. Shielded cable connected incorrectly or shorted. 5. FUNCTION switch is in the STBY position. 6. Refer to the "IF/Audio Troubleshooting Chart."
No IF output.	1. Shorting spring not removed from Q501. 2. FUNCTION switch is in the STBY position. 3. Refer to the "IF/Audio Troubleshooting Chart."
No output from crystal filters.	1. Switch rotor MS-1 or MS-2 of the MODE switch rotated 180 degrees from its correct position or incorrectly wired. 2. Resistor R705 incorrectly installed or open. 3. Coaxial cable from wafer MS-2 of the MODE switch wired incorrectly or shorted.
No output from the second mixer.	1. Shorting spring not removed from Q204. 2. Coaxial cable from MODE switch wafer MS-1 wired incorrectly or shorted. 3. LMO incorrectly wired or inoperative. 4. Coaxial cable connected to LMO OUT jack wired incorrectly or shorted. 5. FUNCTION switch is in the STBY position. 6. Refer to the "Mixer Troubleshooting Chart."
No output from the first mixer.	1. Shorting spring not removed from Q203. 2. Coaxial cable connected to HFO OUT jack improperly wired or shorted. 3. HFO not connected or inoperative. 4. FUNCTION switch is in the STBY position. 5. Refer to the "Mixer Troubleshooting Chart."

SYMPTOM	POSSIBLE CAUSE
HFO does not operate.	1. Coaxial cable connected to HFO jack on the rear panel, shorted. 2. Refer to the "Heterodyne Oscillator Troubleshooting Chart."
No output from the RF amplifier.	1. Shorting spring not removed from Q101. 2. Connections not made to the antenna and RF amplifier Switch-Boards from preselector capacitor sections C701A, C701B, C701C, or C701D. 3. FUNCTION switch in STBY position. 4. Cable not connected to ANTENNA INPUT on the antenna Switch-Board. 5. Refer to the "Antenna Troubleshooting Chart."
AGC does not operate.	1. Diode D701 installed backward or shorted. 2. AGC switch wired incorrectly. 3. Refer to the "IF/Audio Troubleshooting Chart."
S meter does not operate.	1. Wires connected to S meter reversed. 2. S meter defective. 3. AGC switch OFF. 4. Refer to the "IF/Audio Troubleshooting Chart."
Calibrator does not operate.	1. FUNCTION switch wired incorrectly. 2. Capacitor C702 not installed. 3. Refer to the "Power Supply/BFO Troubleshooting Chart."
RTTY does not operate.	1. Switch wafer MS-3 of the MODE switch incorrectly wired or rotated 180 degrees from its correct position. 2. Accessory socket incorrectly wired. 3. Refer to the "RTTY Troubleshooting Chart."
Noise output that varies with the Main Tuning, under no signal conditions.	1. Either LMO load resistor or companion transmitter not plugged into the rear panel LMO out jack, or an open circuit.

CHASSIS PHOTOGRAPHS

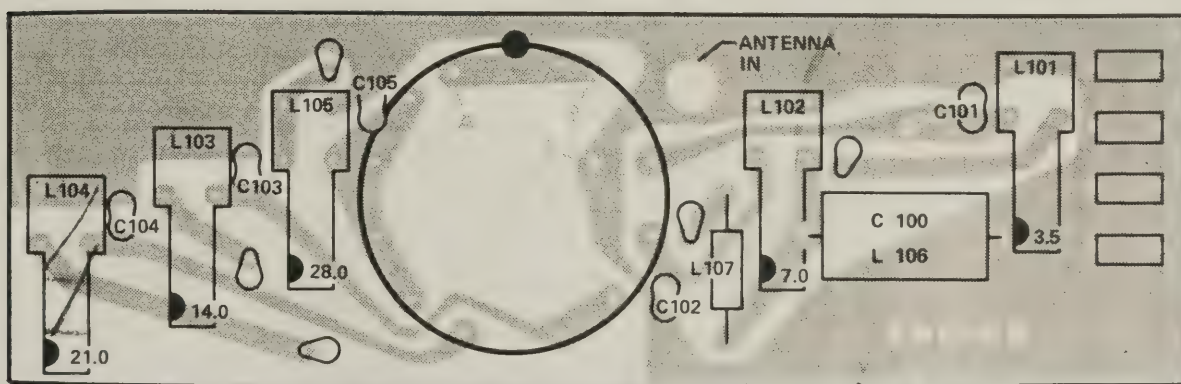




ANTENNA SWITCH-BOARD

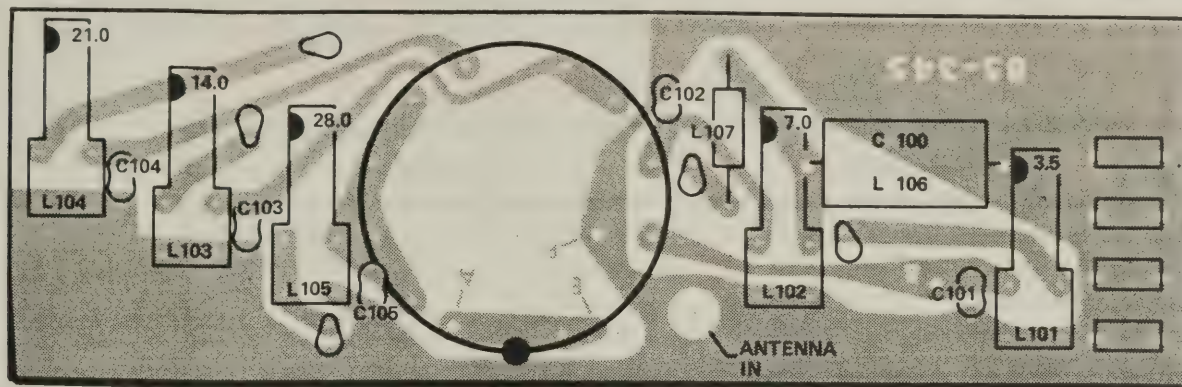
TROUBLESHOOTING CHART

SYMPTOM	POSSIBLE CAUSE
No output from the RF amplifier,	1. Antenna coils incorrectly tuned. 2. Switch rotor BS-1 or BS-2 of the BAND switch rotated 180 degrees from their correct position. 3. Switch wafer BS-1 of the BAND switch wired incorrectly to the circuit board. 4. Coaxial cable shorted. 5. Refer to the "RF Amplifier Troubleshooting Chart."

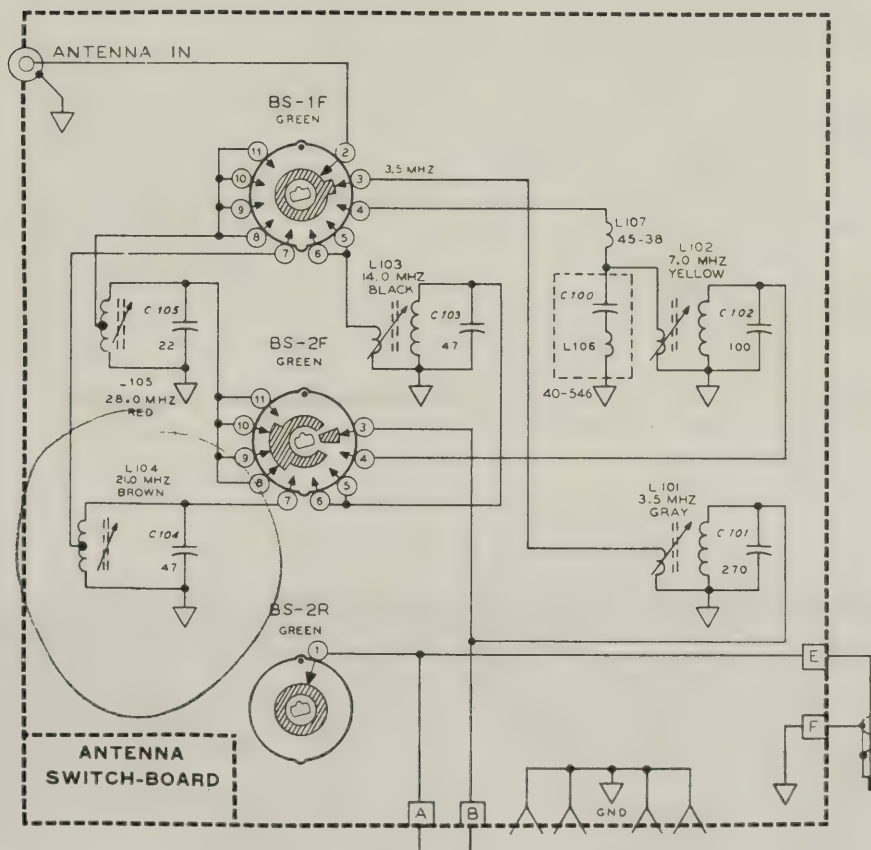


X-RAY VIEW
(SHOWN FROM COMPONENT SIDE)





X-RAY VIEW
(SHOWN FROM FOIL SIDE)



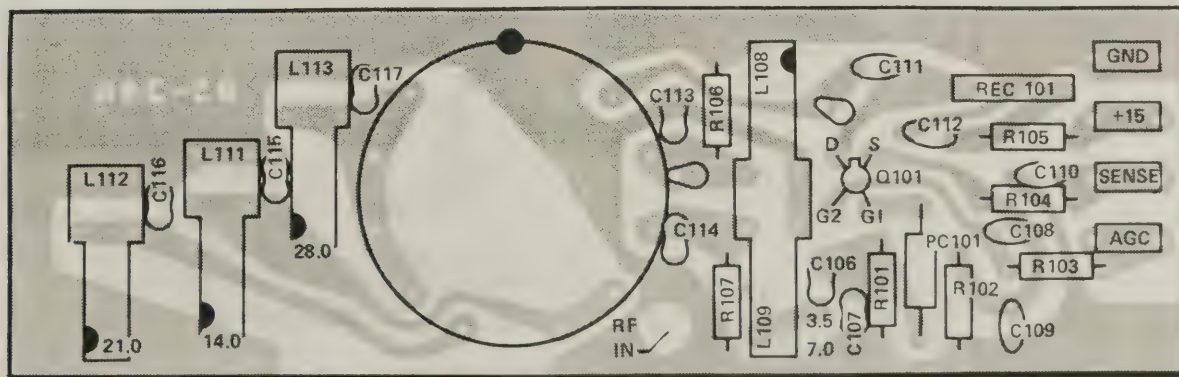
ANTENNA SWITCH-BOARD SCHEMATIC

RF AMPLIFIER SWITCH-BOARD

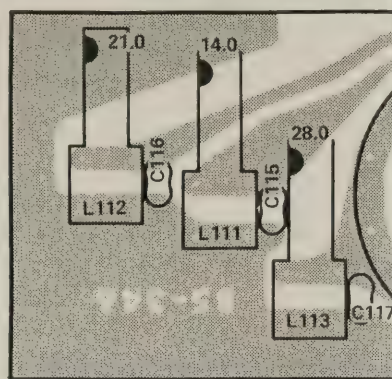
TROUBLESHOOTING CHART

SYMPTOM	POSSIBLE CAUSE
No output from the RF amplifier.	1. Shorting spring not removed from Q101. 2. RF amplifier coils incorrectly tuned. 3. Switch wafer BS-3 of the BAND switch tuned 180 degrees from its correct position. 4. Transistor Q101 incorrectly installed or shorted. 5. RF amplifier Switch-Board connectors not making contact with plug board connectors. 6. Choke RFC101 open. 7. Capacitor C108 or C109 open. 8. Capacitor C112 shorted. 9. Capacitor C111 open. 10. Refer to the "IF/Audio Troubleshooting Chart."
AGC does not operate.	1. Transistor Q101 incorrectly installed or shorted.
S meter does not operate.	1. Transistor Q101 incorrectly installed or shorted. 2. RF amplifier Switch-Board connectors not making contact with plug board connectors.

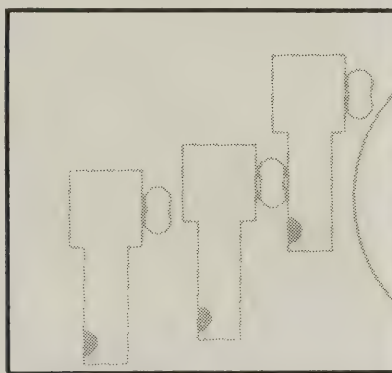
X-RAY VIEW



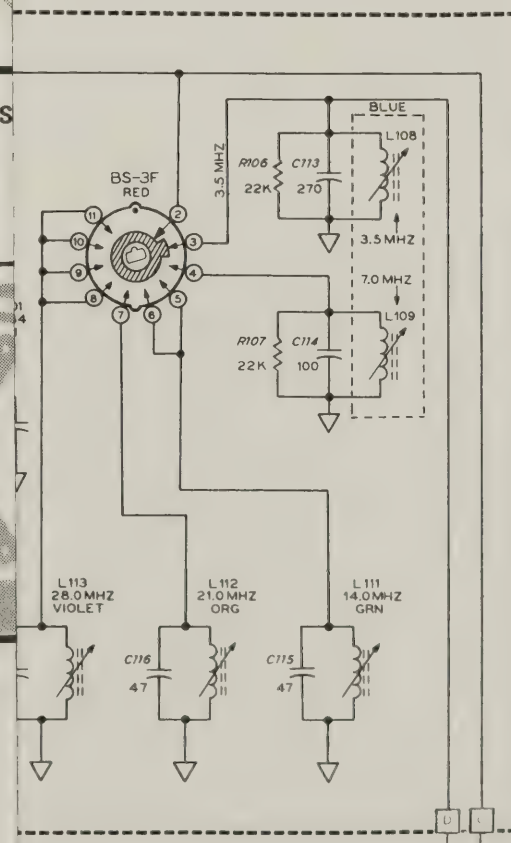
(SHOWN FROM COMPONENT SIDE)



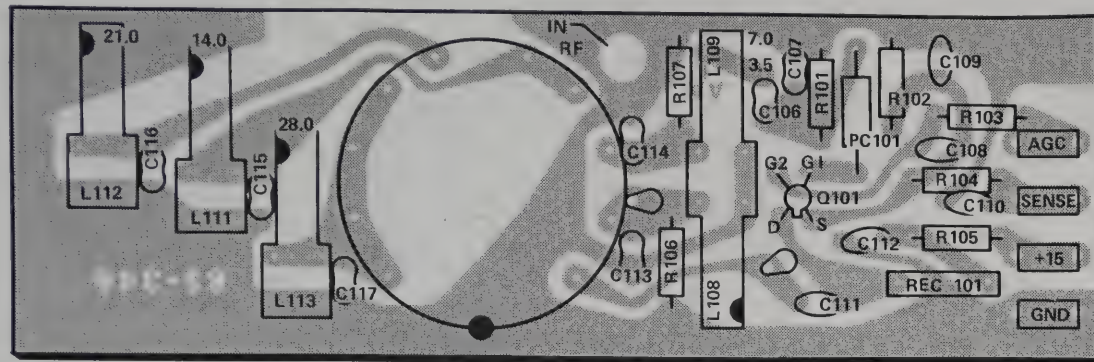
COMPONENT SIDE)



OM FOIL SIDE)

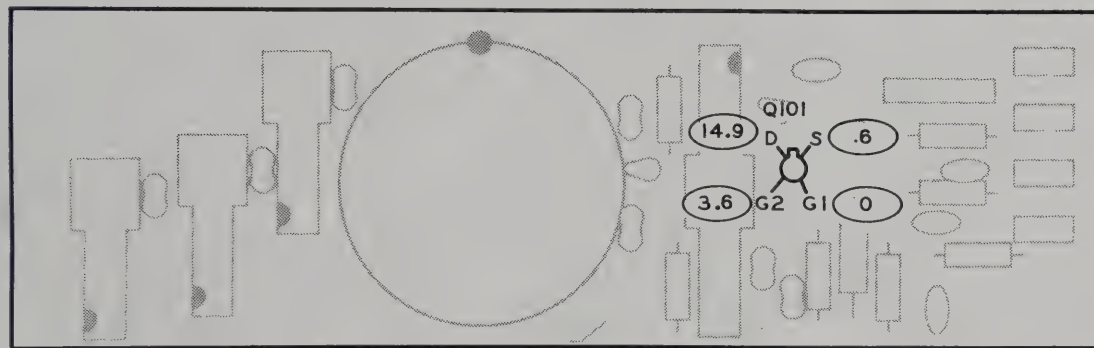


H-BOARD SCHEMATIC

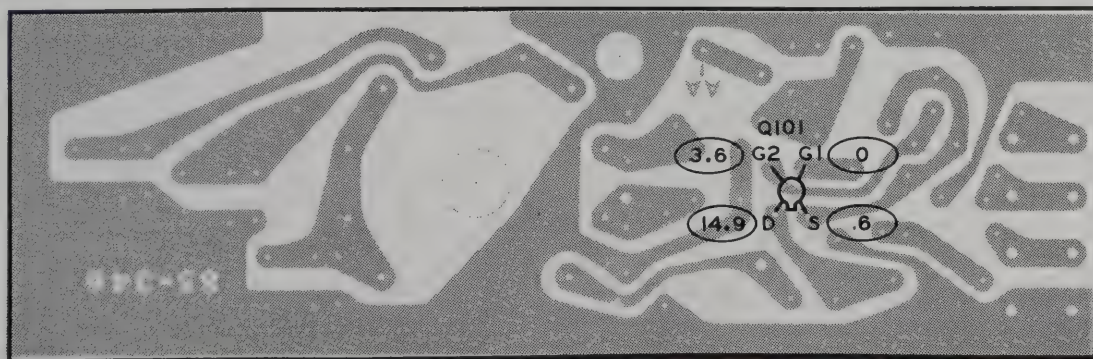


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VOLTAGE CHARTS

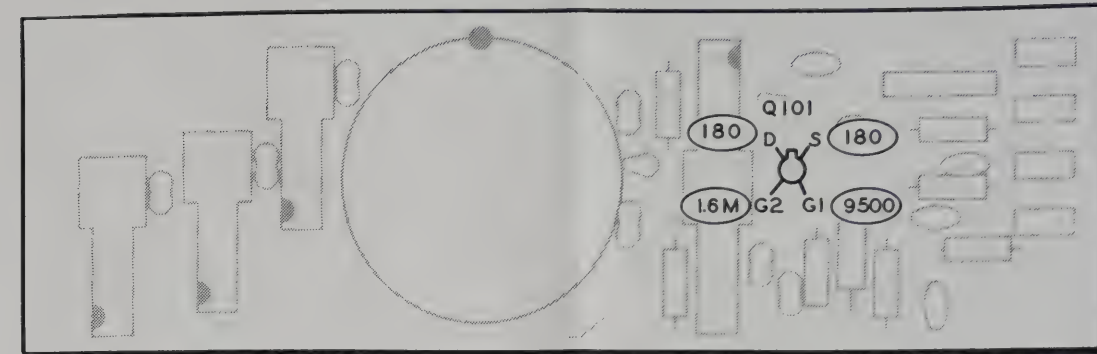


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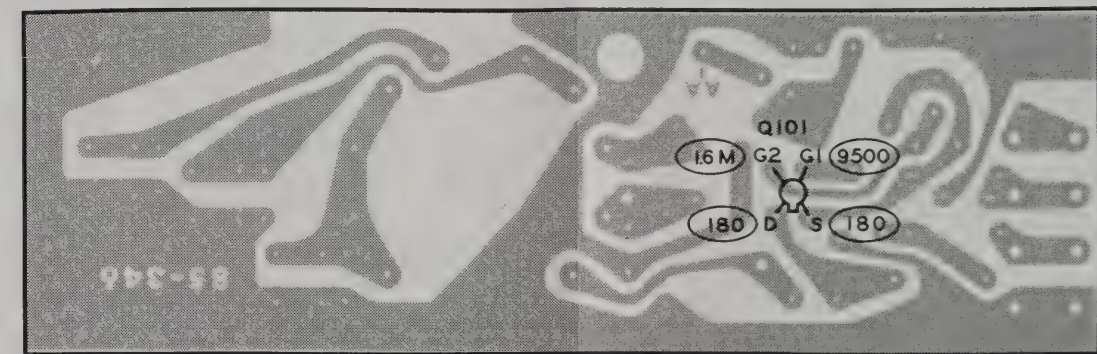


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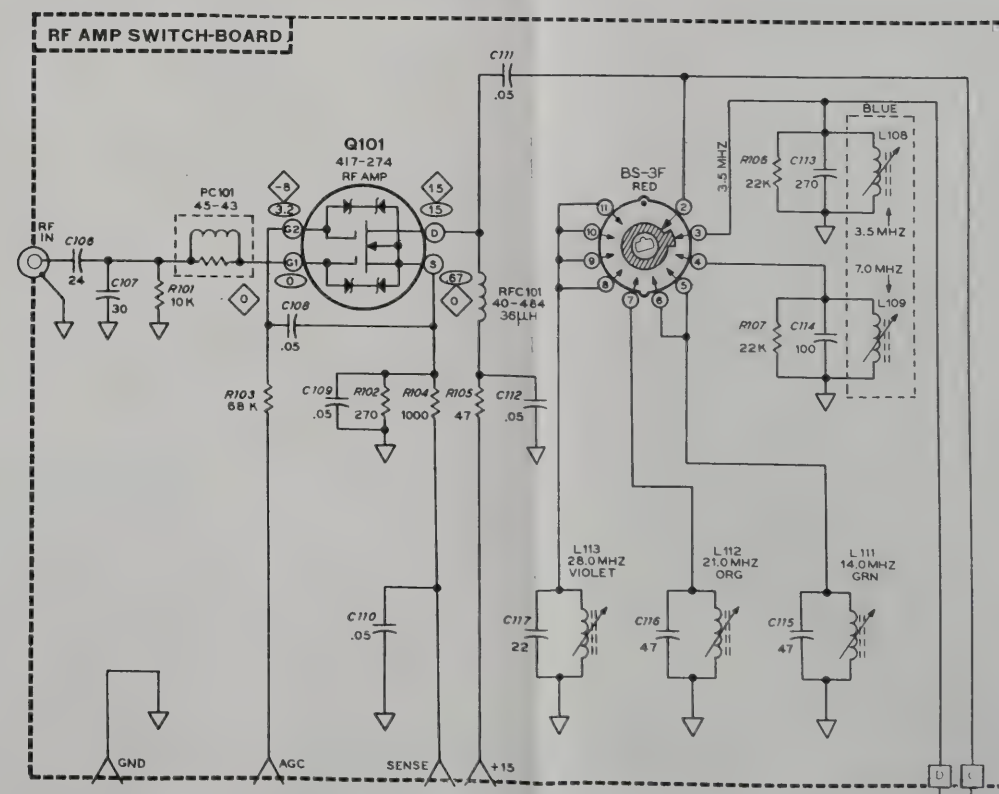
RESISTANCE CHARTS



(SHOWN FROM COMPONENT SIDE)

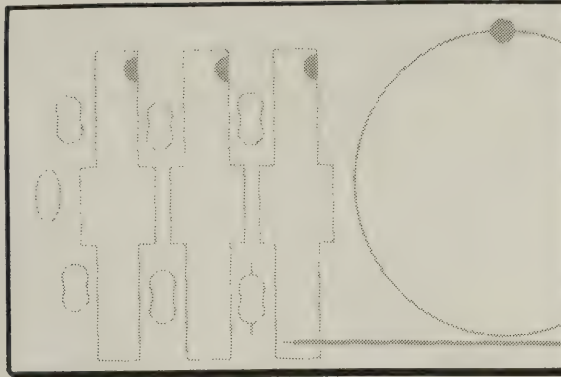


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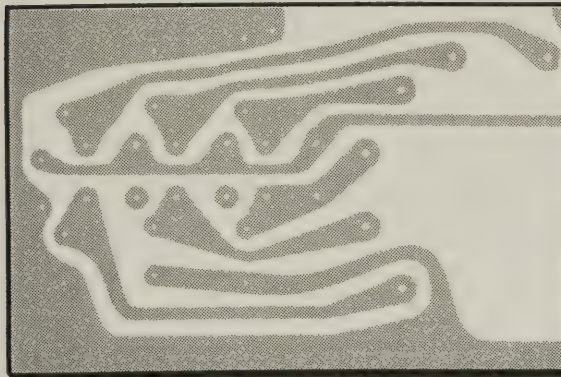


RF AMPLIFIER SWITCH-BOARD SCHEMATIC

RESISTANCE CH-BOARD



(SHOWN FROM



(SHOWN FR

RT

POSSIBLE CAUSE

02 incorrectly installed

18, C119 or C121 shorted.

22 open.

Oscillator Switch-Board not
crystal Switch-Board.

23 open.

BS-4 of the BAND switch
degrees from its correct

ils incorrectly tuned. (It

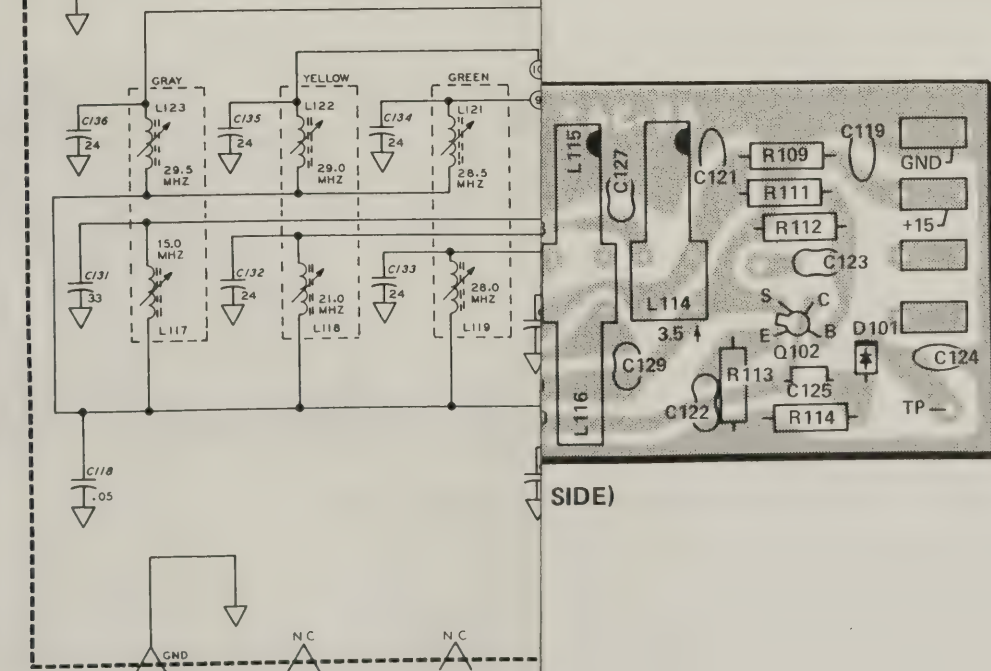
o retune the oscillator coils
tion is made to the HFO OUT jack
anel.)

Oscillator Switch-Board connectors
contact with plug board connectors.

"Crystal Troubleshooting Chart."

HET. OSC. SWITCH-BOARD

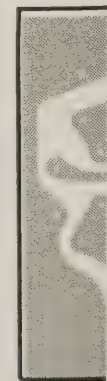
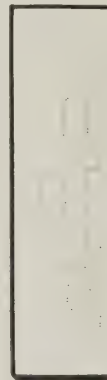
OSC. OUT

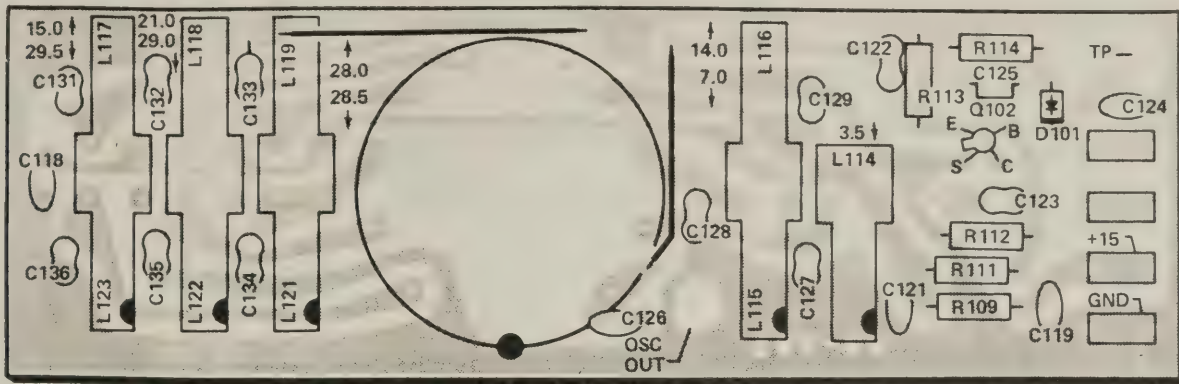


SIDE)

HETERODYNE SWITCH-BOARD

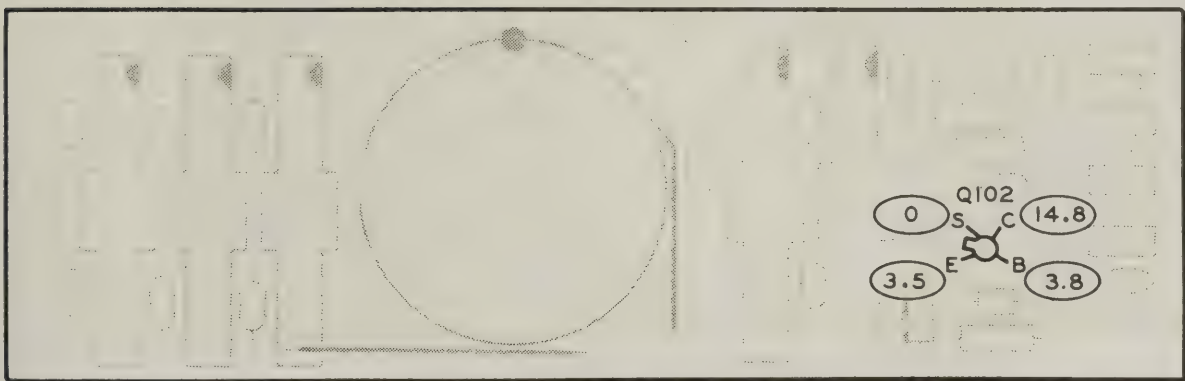
15.0
29.5
C131
C118
C136



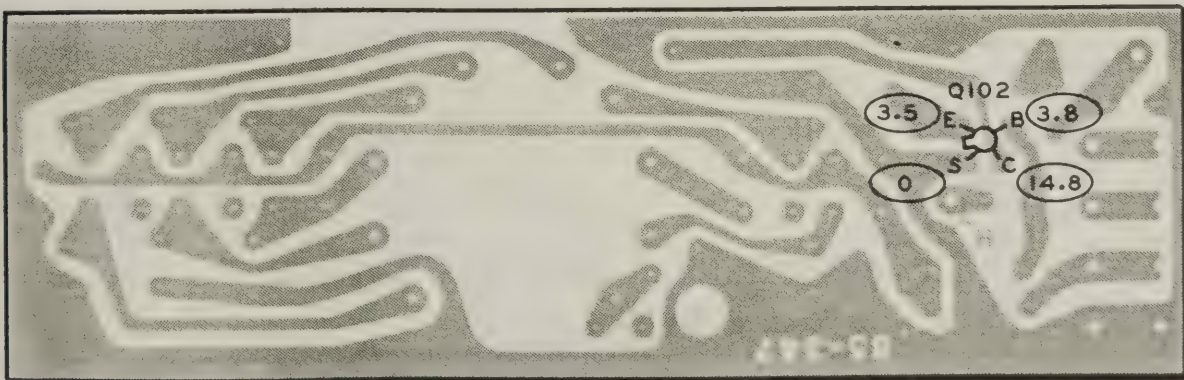


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VOLTAGE CHARTS



(SHOWN FROM COMPONENT SIDE)



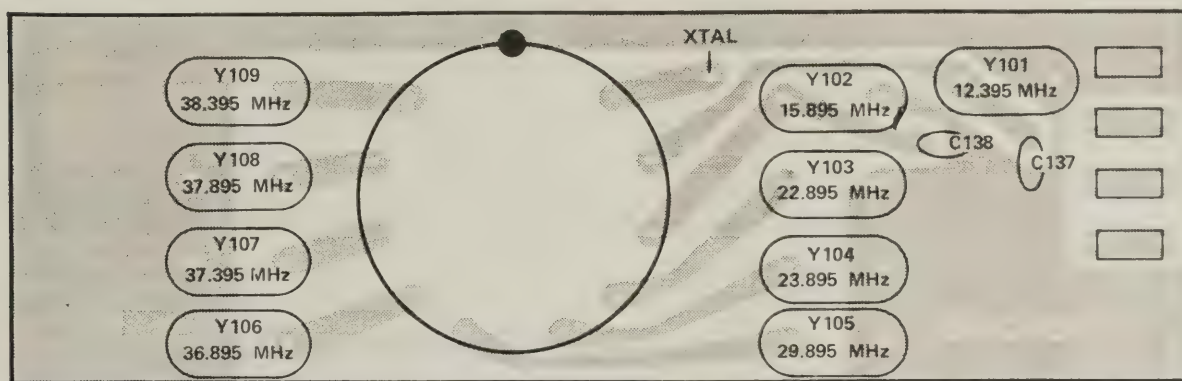
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CRYSTAL SWITCH-BOARD

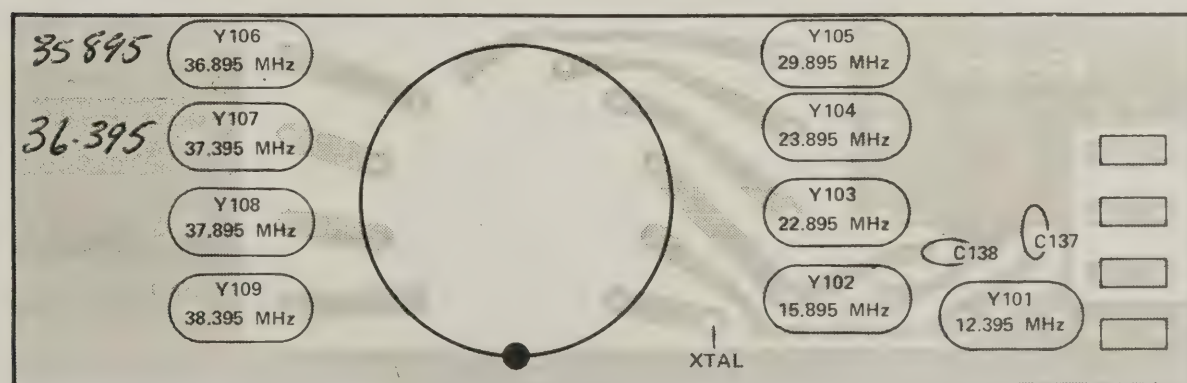
TROUBLESHOOTING CHART

SYMPTOM	POSSIBLE CAUSE
HFO does not operate.	1. Switch wafer BS-5 of the BAND switch rotated 180 degrees from its correct position. 2. Defective crystal, crystal unsoldered, or crystals interchanged. 3. Refer to the "Mixer Troubleshooting Chart."

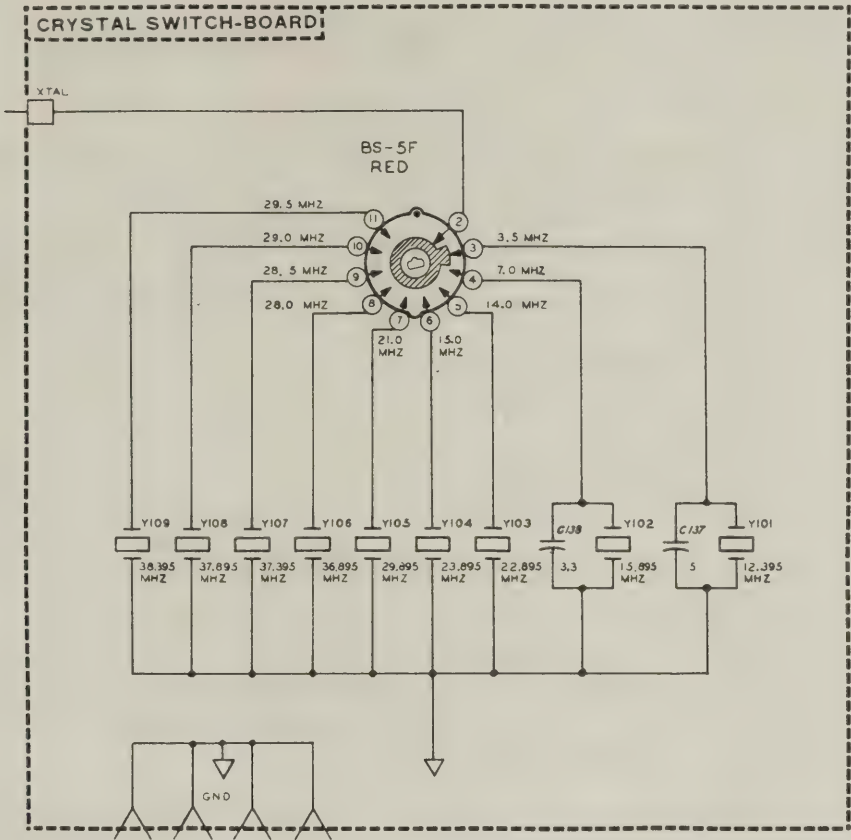
X-RAY VIEWS



(SHOWN FROM COMPONENT SIDE)

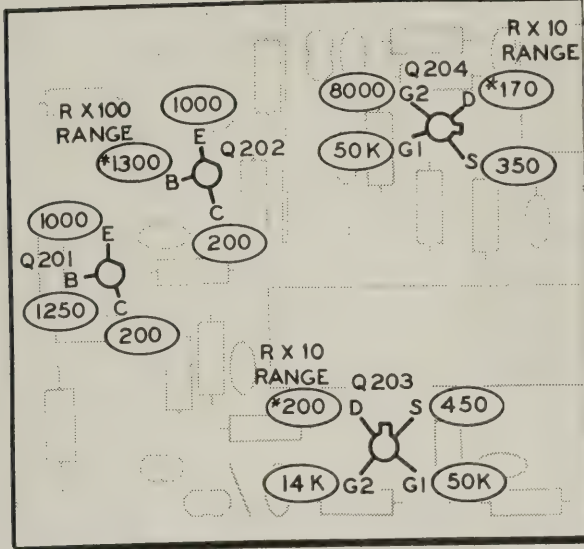


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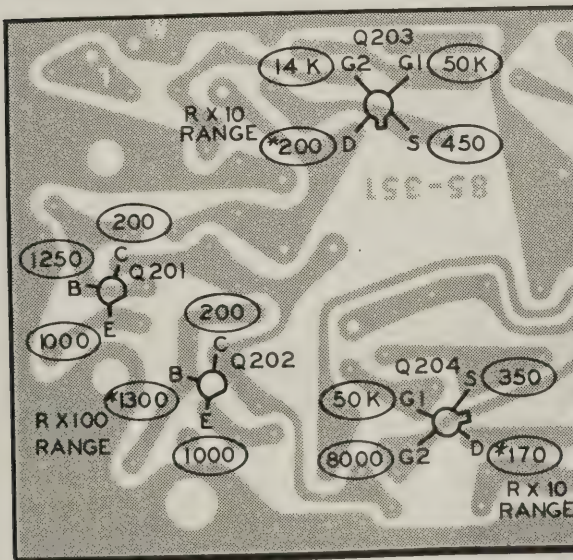
CRYSTAL SWITCH-BOARD SCHEMATIC

RESISTANCE CHA



(SHOWN FROM COMPONENT

* READING VARIES
WITH METER RANGE



(SHOWN FROM FOIL SIDE

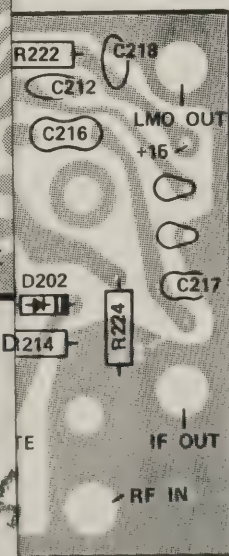
CAUSE

removed from Q204.
d or shorted.
ed backward or
correctly installed or
219 or C221 shorted.
sis Troubleshooting

removed from Q203.
ed backward or

connected to
the mixer circuit

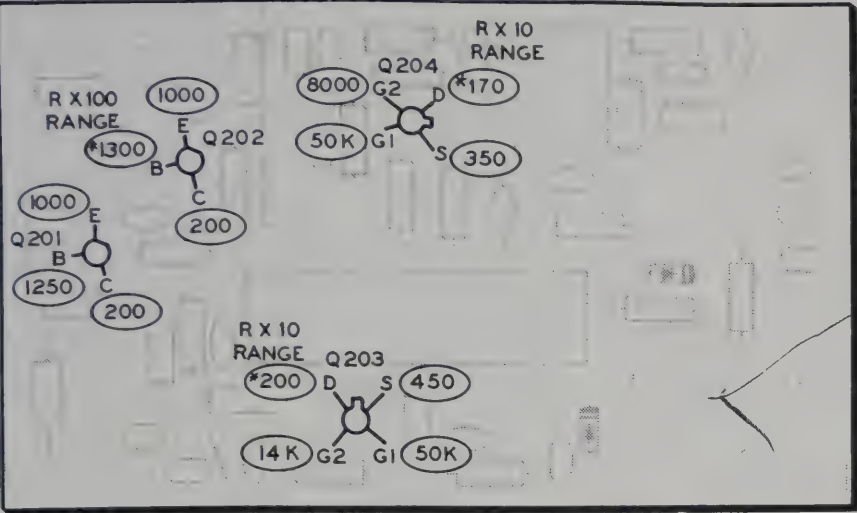
Q202 incorrectly



410059

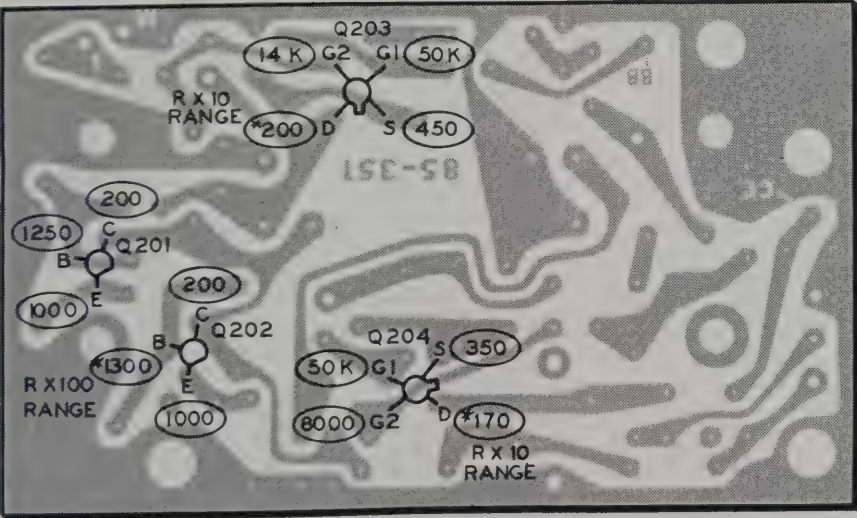
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RESISTANCE CHARTS



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* READING VARIES
WITH METER RANGE



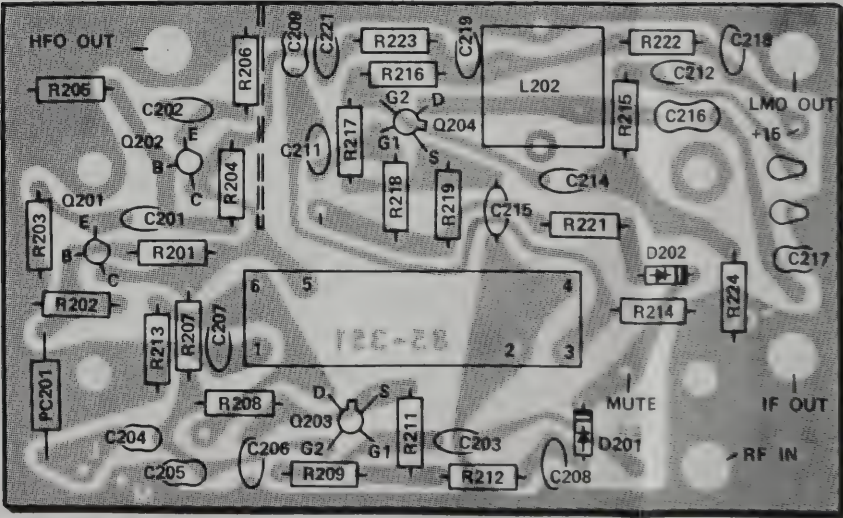
(SHOWN FROM FOIL SIDE)

MIXER CIRCUIT BOARD

TROUBLESHOOTING CHART

SYMPTOM	POSSIBLE CAUSE
No output from the second mixer.	1. Shorting spring not removed from Q204. 2. Coil L202 not tuned or shorted. 3. Diode D202 installed backward or shorted. 4. Transistor Q204 incorrectly installed or shorted. 5. Capacitor C218, C219 or C221 shorted. 6. Refer to the "Chassis Troubleshooting Chart."
No output from the first mixer.	1. Shorting spring not removed from Q203. 2. Diode D201 installed backward or shorted.
HFO does not operate.	1. Coaxial cable not connected to HFO OUT jack on the mixer circuit board. 2. Transistor Q201 or Q202 incorrectly installed or shorted.

X-RAY VIEW



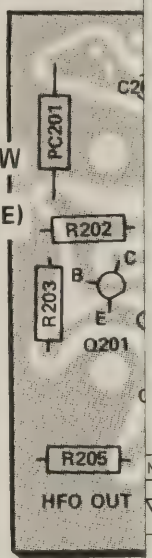
(SHOWN FROM COMPONENT SIDE)

40059

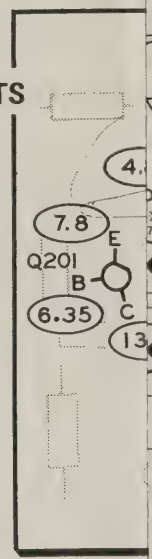
28.025

3.895
3.5895
3.790
28.0375

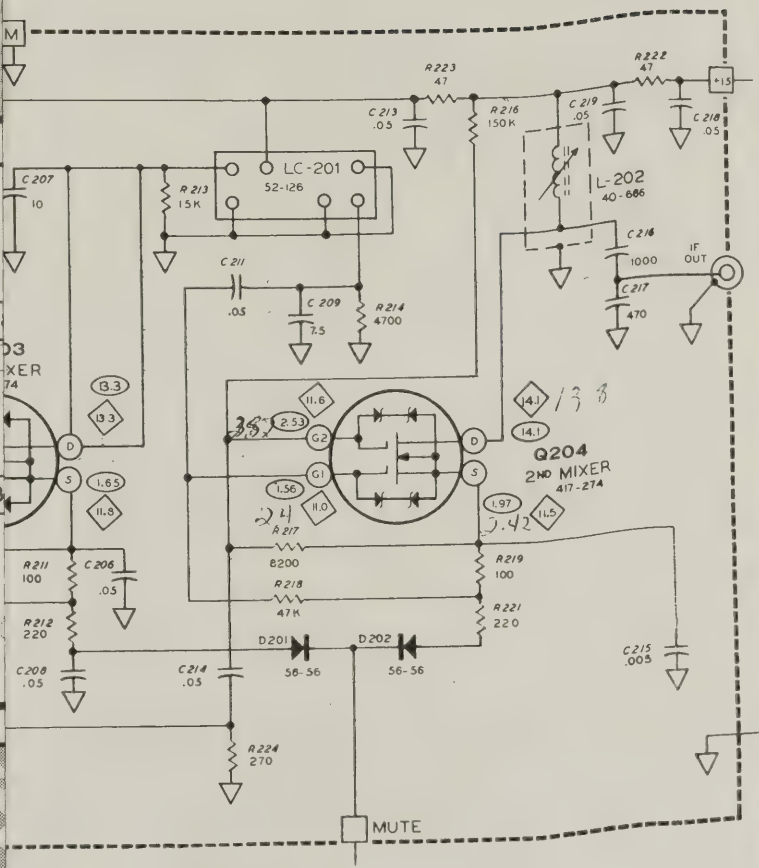
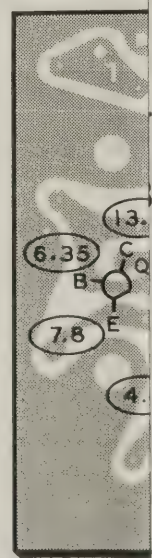
X-RAY VIEW
(SHOWN FROM FOIL SIDE)



VOLTAGE CHARTS
(SHOWN FROM COMPONENT SIDE)

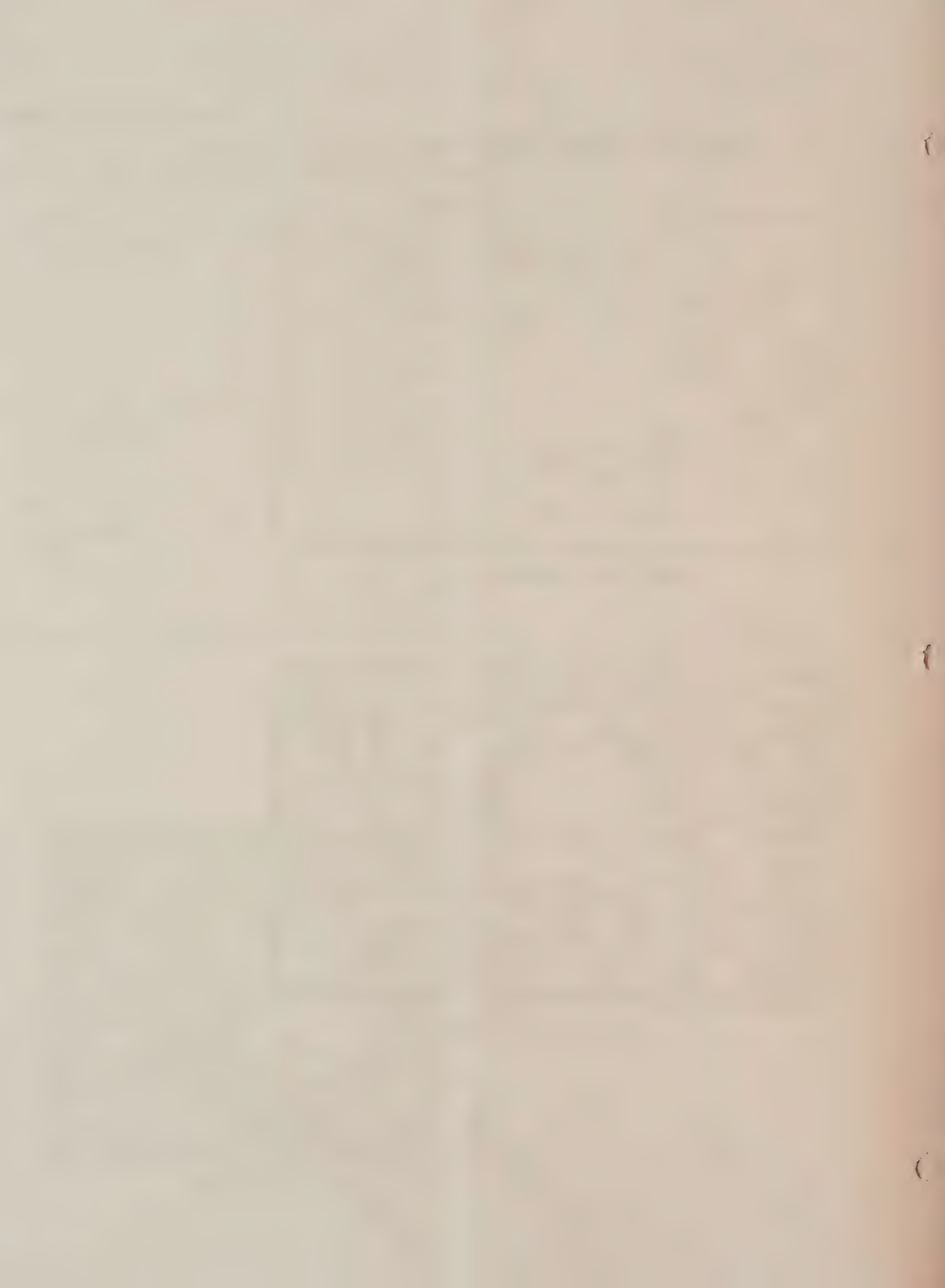


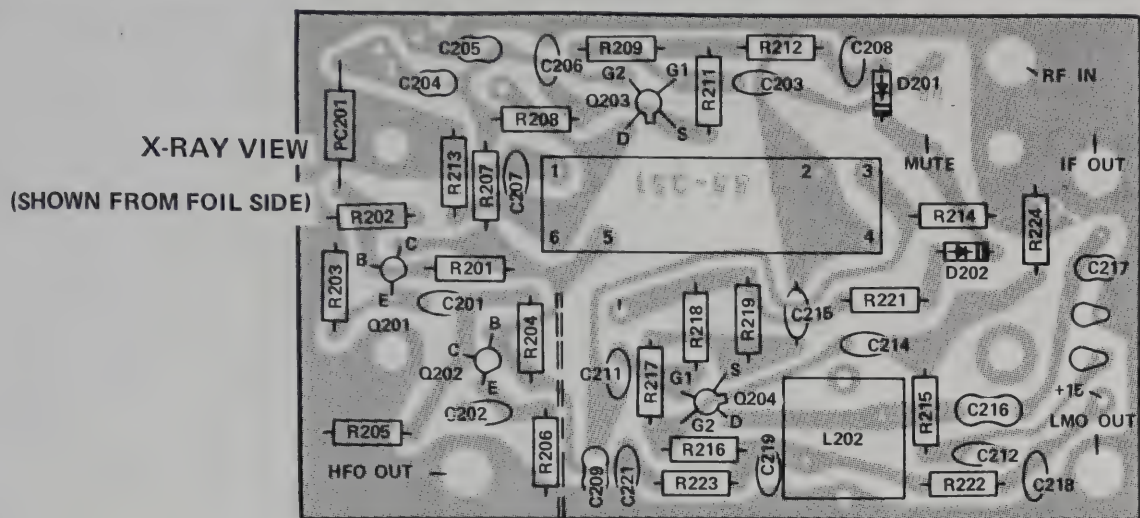
(SHOWN FROM
FOIL SIDE)



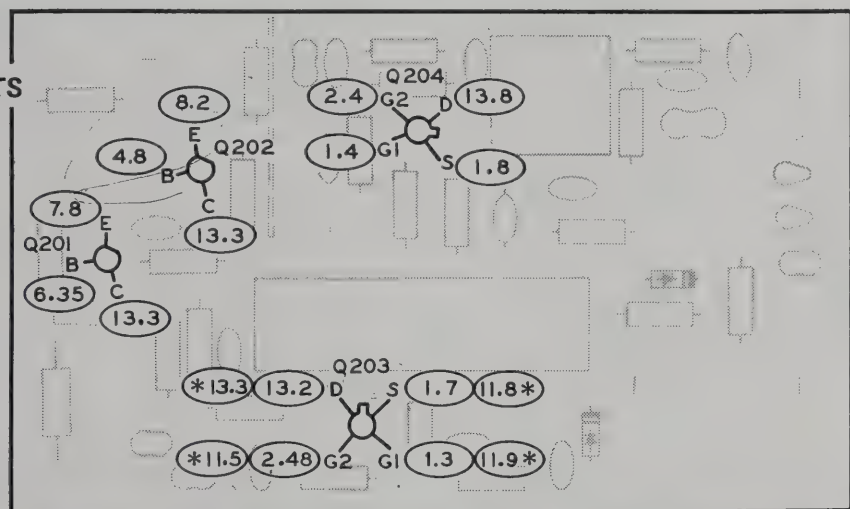
BOARD SCHEMATIC

*RECEIVE

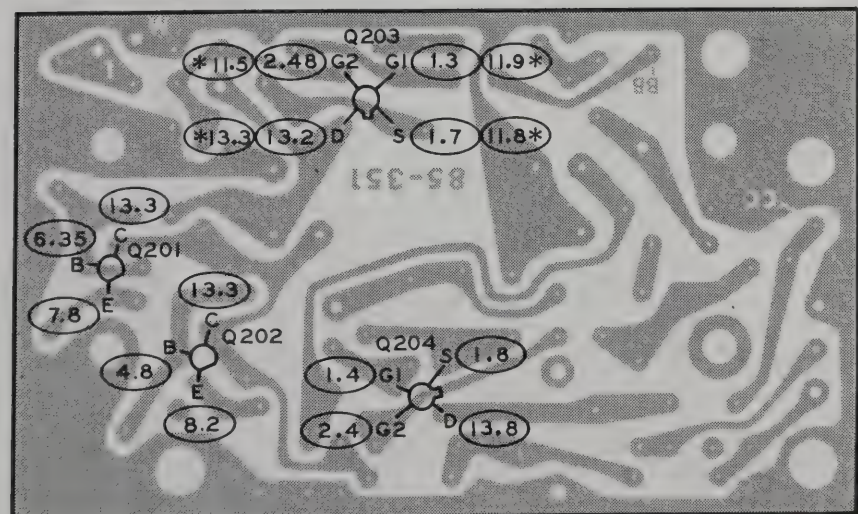




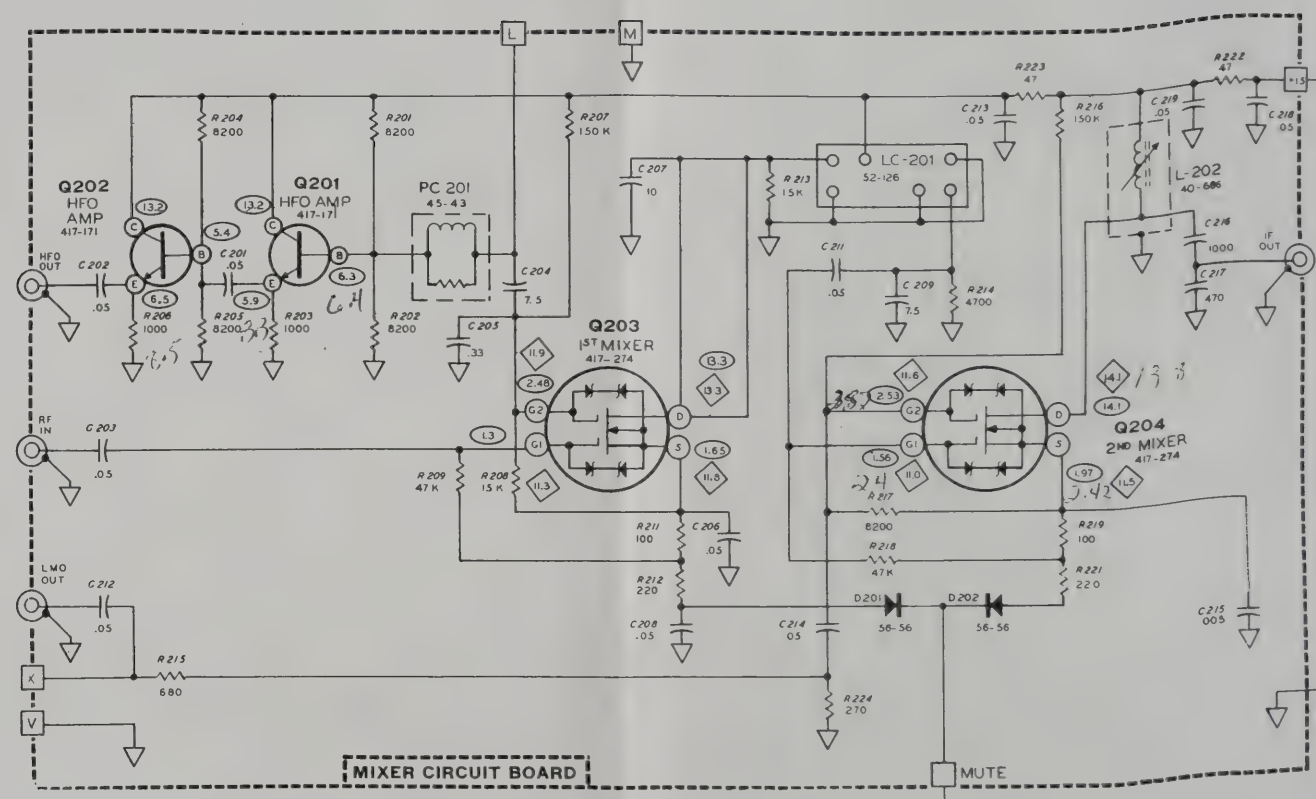
VOLTAGE CHARTS
(SHOWN FROM COMPONENT SIDE)



(SHOWN FROM FOIL SIDE)



*RECEIVER IS IN STANDBY



MIXER CIRCUIT BOARD SCHEMATIC

CAUSE

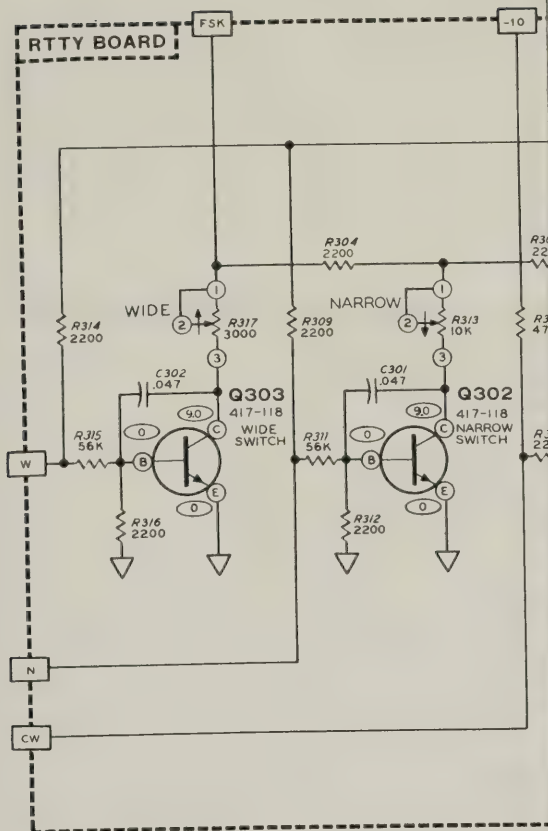
installed backward

B or R317 open.

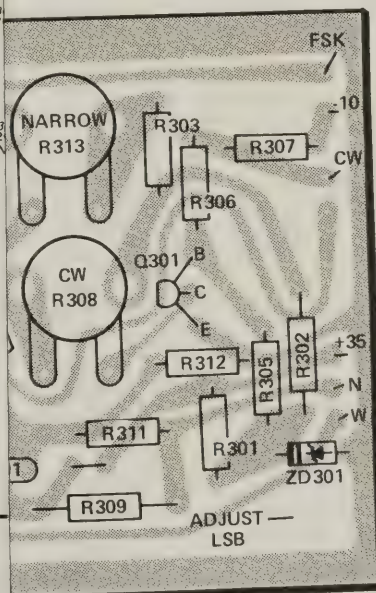
302, or Q303

or shorted.

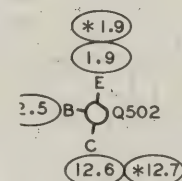
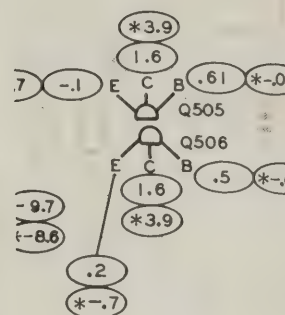
d foil not making
ing clips.



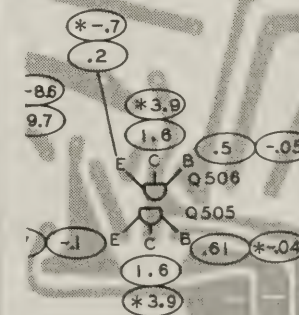
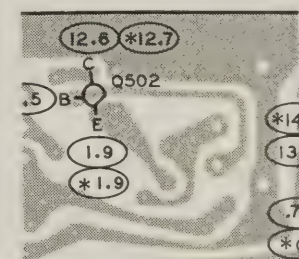
RTTY CIRCUIT BOARD



OWN FROM FOIL SIDE)



(SHOWN FROM

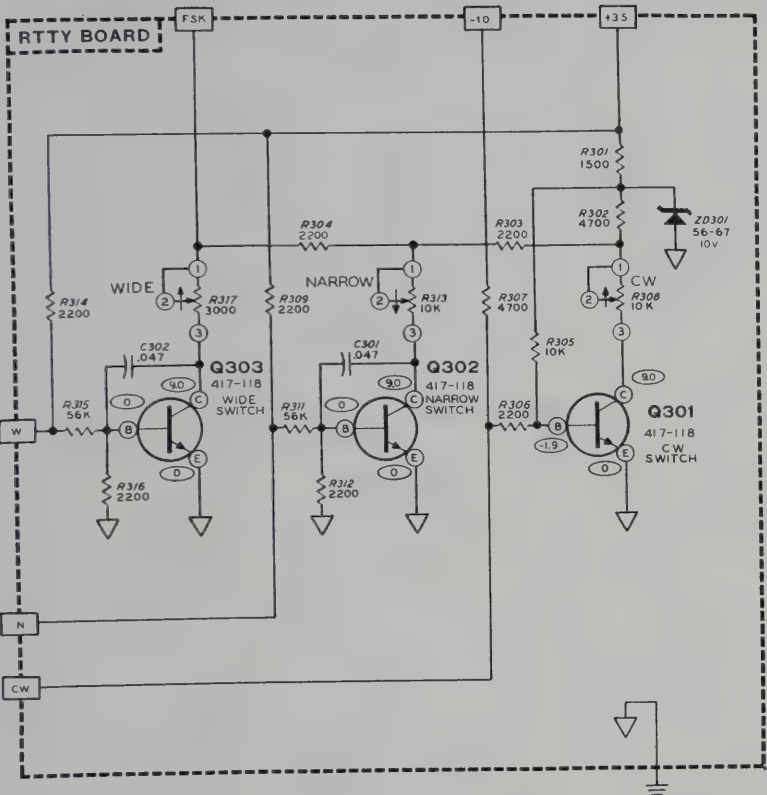


(SHOWN FR

RTTY CIRCUIT BOARD

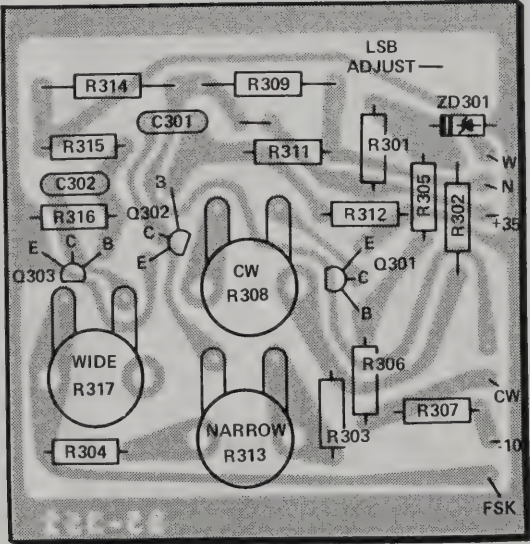
TROUBLESHOOTING CHART

SYMPTOM	POSSIBLE CAUSE
RTTY does not operate.	1. Zener diode ZD301 installed backward or shorted. 2. Control R308, R313 or R317 open. 3. Transistor Q301, Q302, or Q303 incorrectly installed or shorted. 4. Circuit board ground foil not making contact with mounting clips.

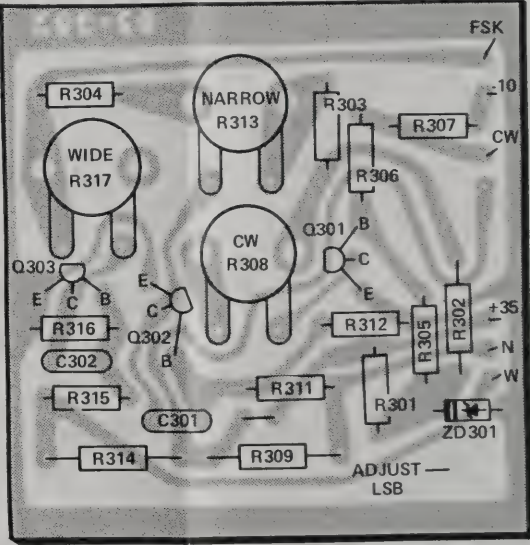


RTTY CIRCUIT BOARD SCHEMATIC

X-RAY VIEWS

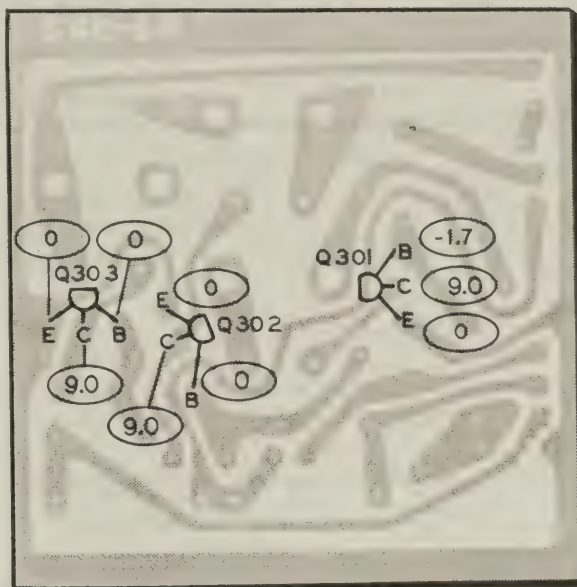
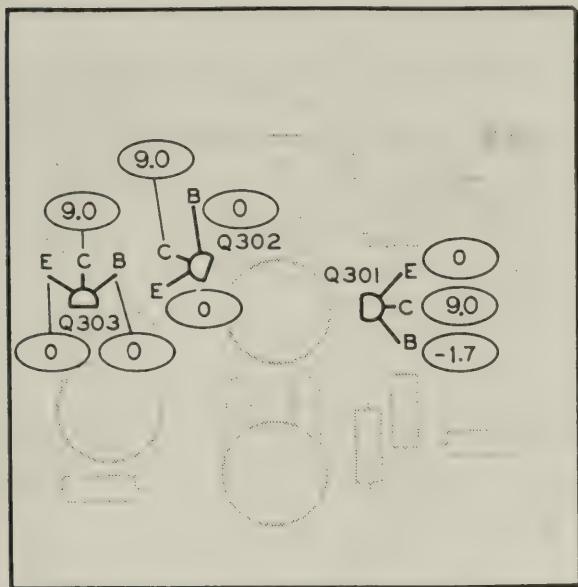


(SHOWN FROM COMPONENT SIDE)



(SHOWN FROM FOIL SIDE)

VOLTAGE CHARTS



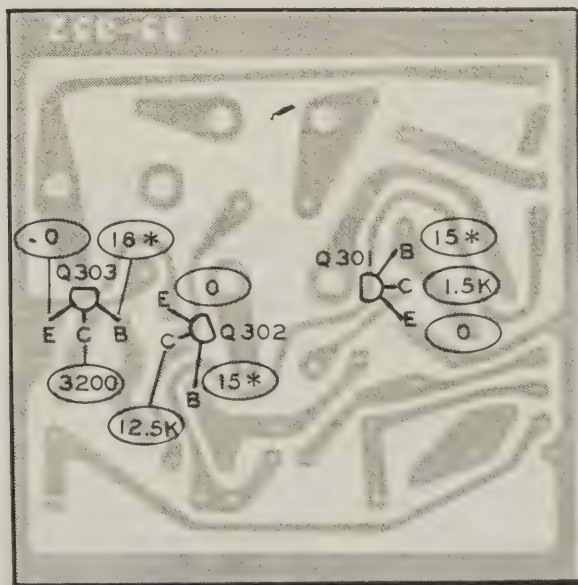
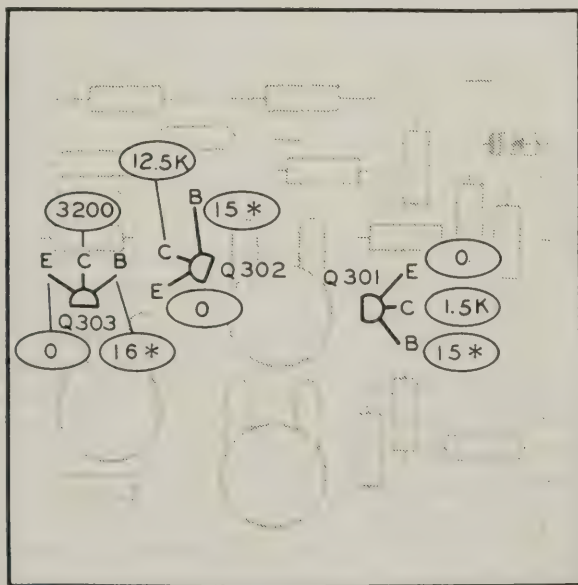
VOLTAGES MEASURED WITH ACCESSORY SOCKET LUGS 1 AND 5 GROUNDED, AND LUG 7 OPEN. MODE SWITCH IN RTTY POSITION.

(SHOWN FROM COMPONENT SIDE)

(SHOWN FROM FOIL SIDE)

NOTE: VOLTAGE AND RESISTANCE MEASUREMENTS ARE DEPENDENT UPON SETTINGS OF CONTROLS R308, R313, AND R317.

RESISTANCE CHARTS



* FORWARD BIASED DIODE OR TRANSISTOR JUNCTION MAKES READING DEPENDENT ON OHMMETER RANGE.

(SHOWN FROM COMPONENT SIDE)

(SHOWN FROM FOIL SIDE)

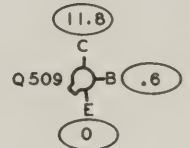
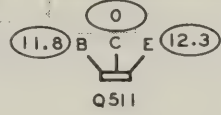
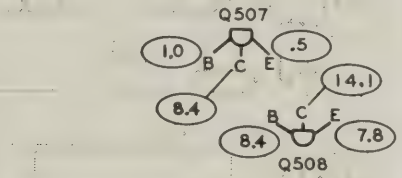
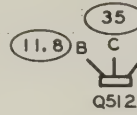
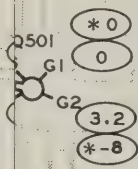
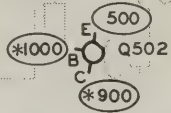
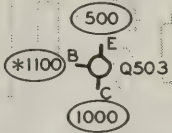
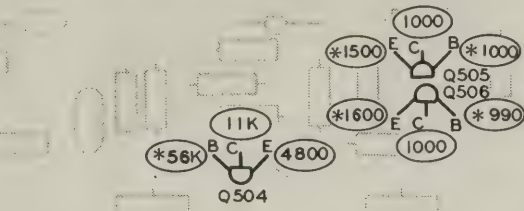
IF/AUDIO CIRCUIT BOARD

TROUBLESHOOTING CHART

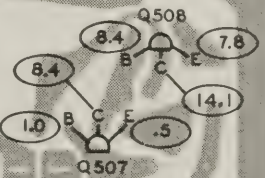
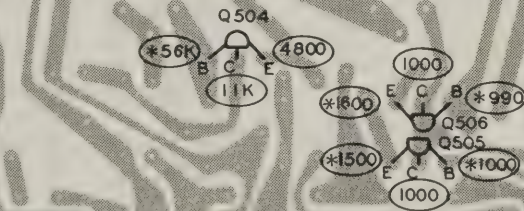
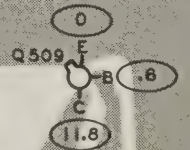
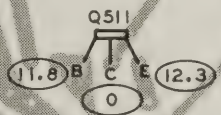
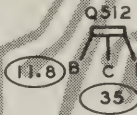
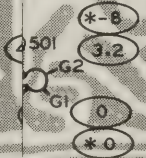
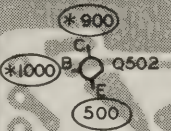
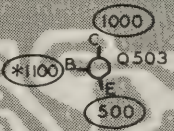
SYMPTOM	POSSIBLE CAUSE
No audio output.	1. Resistor <u>R556</u> faulty, or transistor Q511 or Q512 <u>incorrectly</u> installed or shorted (check mica insulator placement). 2. Transistor Q509 open (normally runs warm to the touch). 3. The rotor in switch wafer MS-4 of the MODE switch, turned 180 degrees from its correct position. 4. BFO not operating. 5. Transistors Q507 and/or Q508.
BFO does not operate.	1. Shielded cable connected at J and K on the IF/Audio circuit board shorted. 2. Shielded cable lead at J and K on the IF/Audio circuit board interchanged. 3. BFO not operating, refer to the "Power Supply/BFO Troubleshooting Chart."
Product detector does not operate.	1. Diode D501, D502, D503 or D504 installed backward or shorted. 2. Capacitor C513 or C514 shorted. 3. BFO not operating. 4. Transformer T503 secondary damaged. 5. BFO not operating. 6. Refer to the "Power Supply/BFO Troubleshooting Chart."
AM detector does not operate.	1. Diode D505 or D506 installed backward or shorted. 2. Capacitor C515 shorted. 3. Capacitor C516 shorted.
No IF output.	1. Shorting spring not removed from Q501. 2. Transformer T501, T502, or T503 shorted. 3. RFC501 open. 4. Capacitor C516 or C517 shorted. 5. Capacitor C508, C509, C511 or C512 shorted. 6. Diode D513 installed backward or shorted. 7. Transistor Q501, R502 or Q503 <u>incorrectly</u> installed or shorted.
No output from the RF Amplifier.	1. AGC voltage incorrect. 2. BIAS ADJ control on the IF/Audio circuit board set incorrectly.
AGC does not operate.	1. Diode D507 or D508 installed backward or shorted. 2. Capacitor C518 or C519 shorted. 3. Capacitor C521 reversed. 4. Transistor Q501 shorted. 5. Refer to the "RF Amplifier Troubleshooting Chart."
S meter does not operate.	1. Transistor Q501, Q505 or Q506 <u>incorrectly</u> installed or shorted. 2. Meter ZERO or METER FULL SCALE controls not adjusted properly. 3. Capacitor C522 shorted. 4. Diode D509 installed backward or shorted. 5. Refer to the "RF Amplifier Troubleshooting Chart."

Name	Address
John Doe 123 Main St Anytown, CA 90210 Phone: 555-1234	John Doe 123 Main St Anytown, CA 90210 Phone: 555-1234
Jane Smith 456 Elm St Beverly Hills, CA 90210 Phone: 555-5678	Jane Smith 456 Elm St Beverly Hills, CA 90210 Phone: 555-5678
Bob Johnson 789 Oak St Los Angeles, CA 90001 Phone: 555-9012	Bob Johnson 789 Oak St Los Angeles, CA 90001 Phone: 555-9012
Alice Brown 101 Pine St San Francisco, CA 94102 Phone: 555-3456	Alice Brown 101 Pine St San Francisco, CA 94102 Phone: 555-3456
Charlie Davis 202 Cedar St New York, NY 10001 Phone: 555-7890	Charlie Davis 202 Cedar St New York, NY 10001 Phone: 555-7890
Diana Evans 303 Birch St Chicago, IL 60601 Phone: 555-2345	Diana Evans 303 Birch St Chicago, IL 60601 Phone: 555-2345
Frank Green 404 Spruce St Houston, TX 77001 Phone: 555-6789	Frank Green 404 Spruce St Houston, TX 77001 Phone: 555-6789
Grace Hill 505 Ash St Phoenix, AZ 85001 Phone: 555-0123	Grace Hill 505 Ash St Phoenix, AZ 85001 Phone: 555-0123

RESISTANCE CHARTS

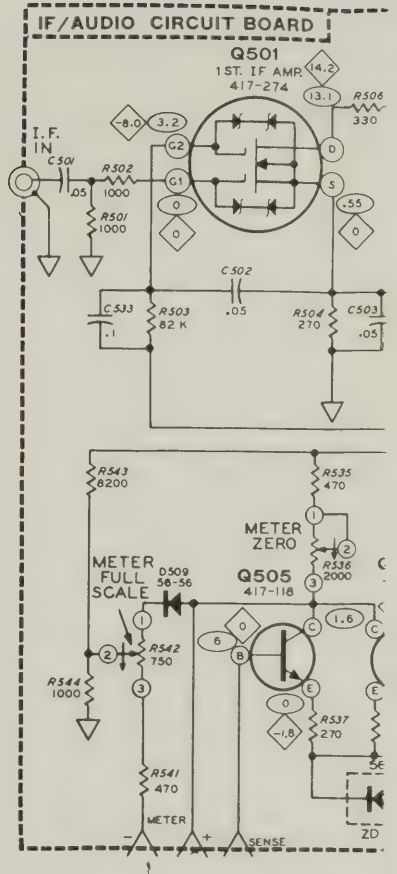
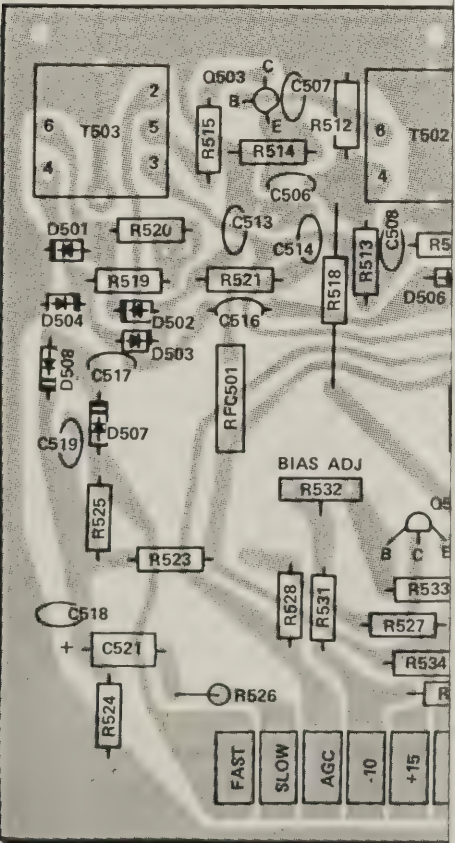
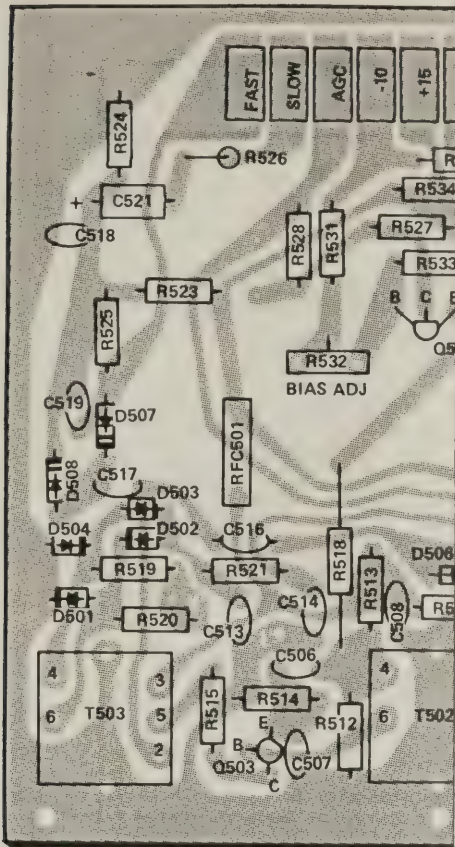


(SHOWN FROM FRONT SIDE)

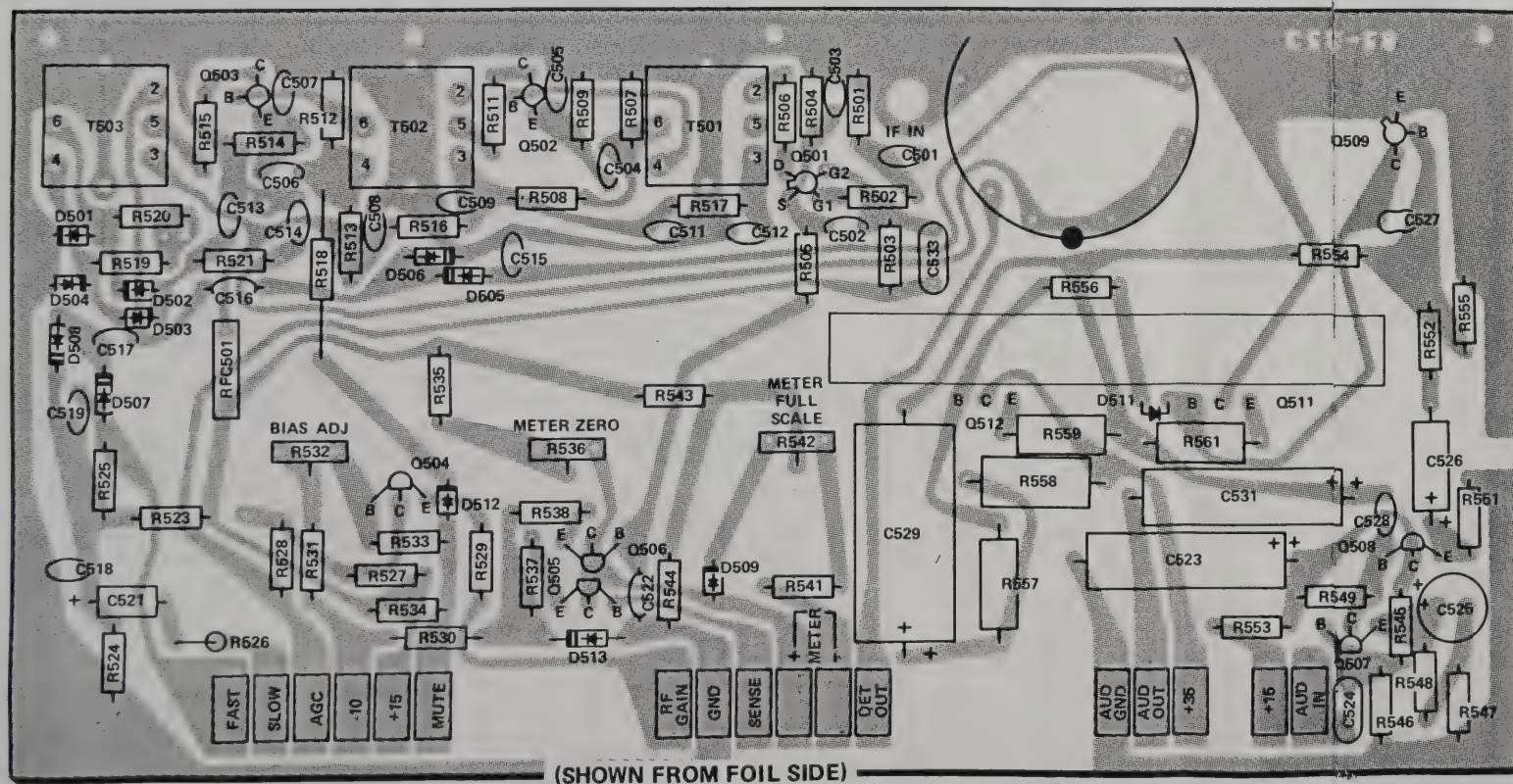


*FORWARD BIASED DIODE OR TRANSISTOR JUNCTION
MAKES READING DEPENDENT ON OHMMETER RANGE.

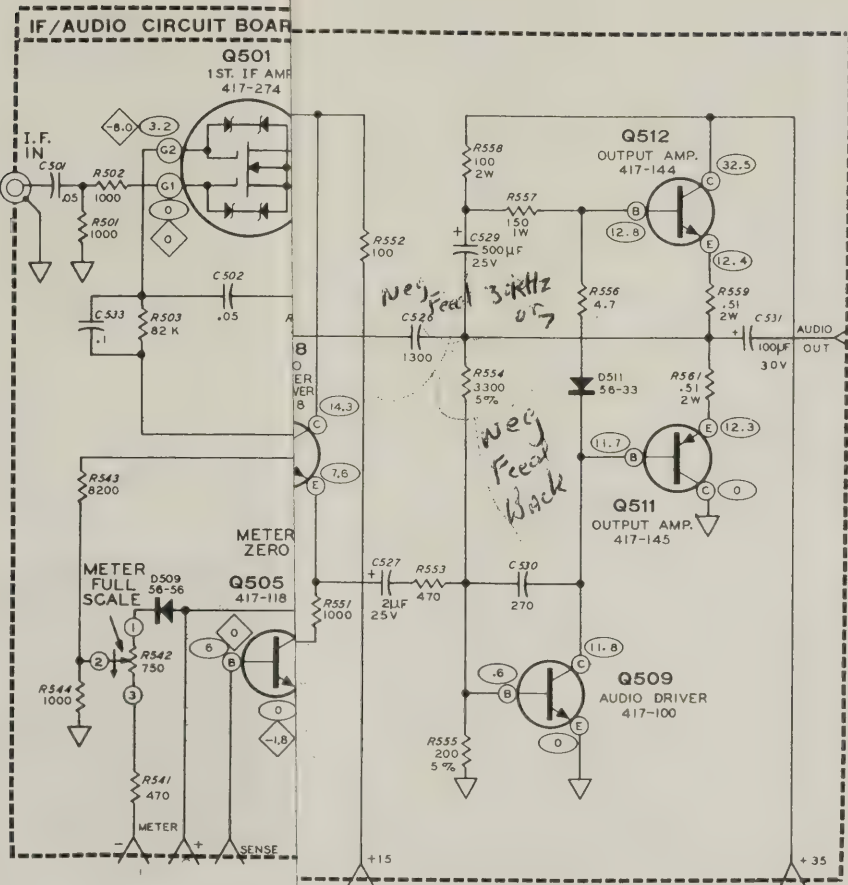
(SHOWN FOIL SIDE)

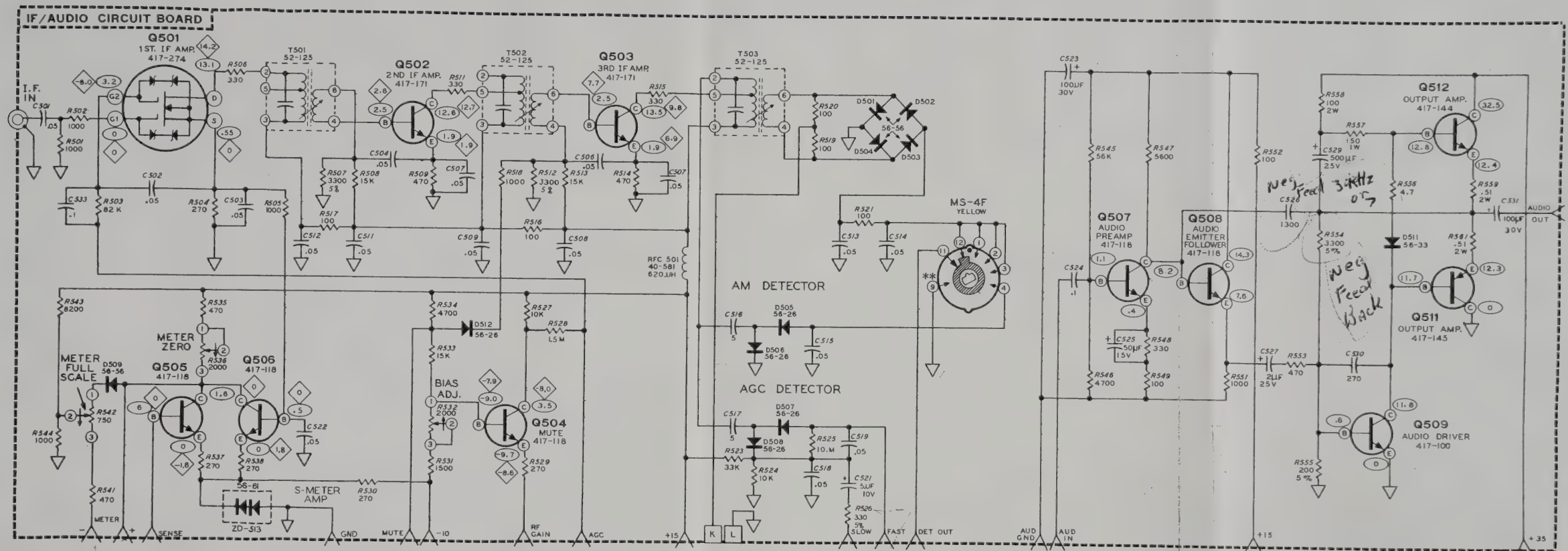


(SHOWN FROM COMPONENT SIDE)



(SHOWN FROM FOIL SIDE)

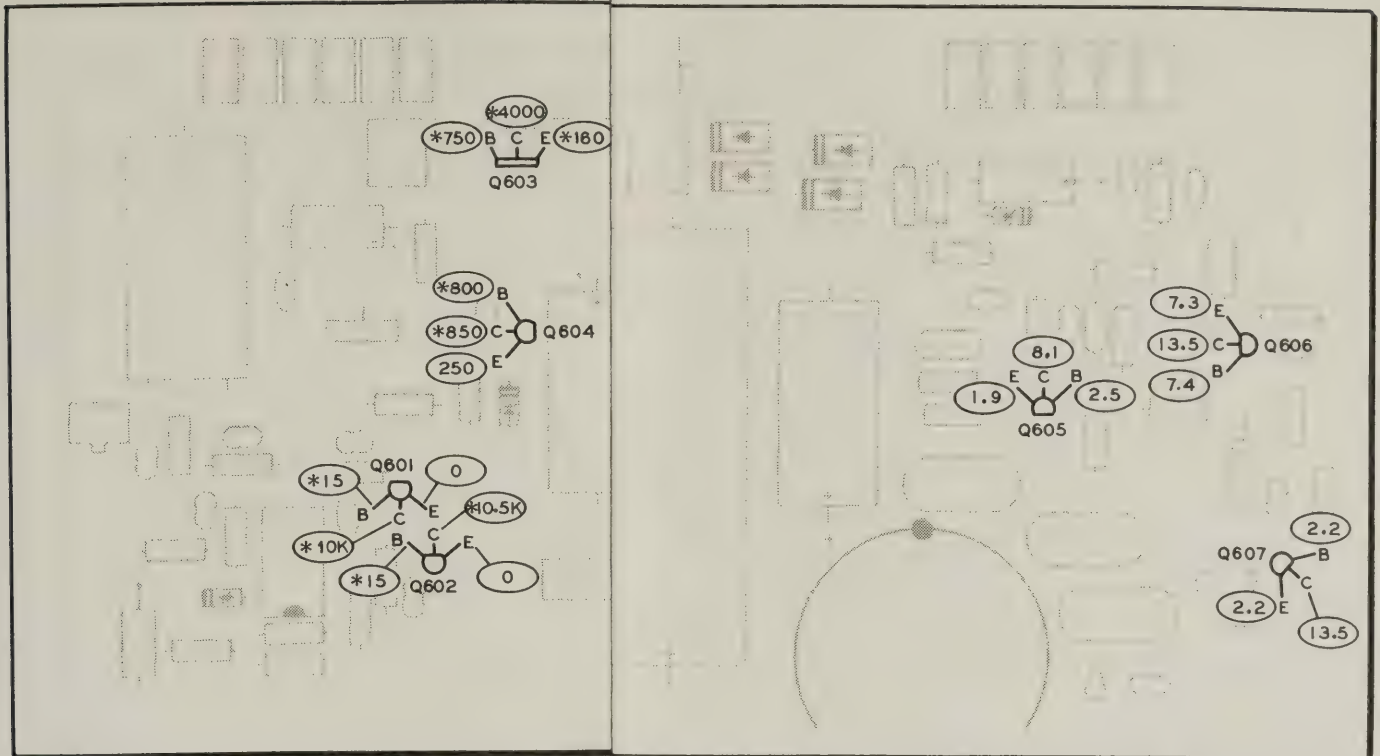




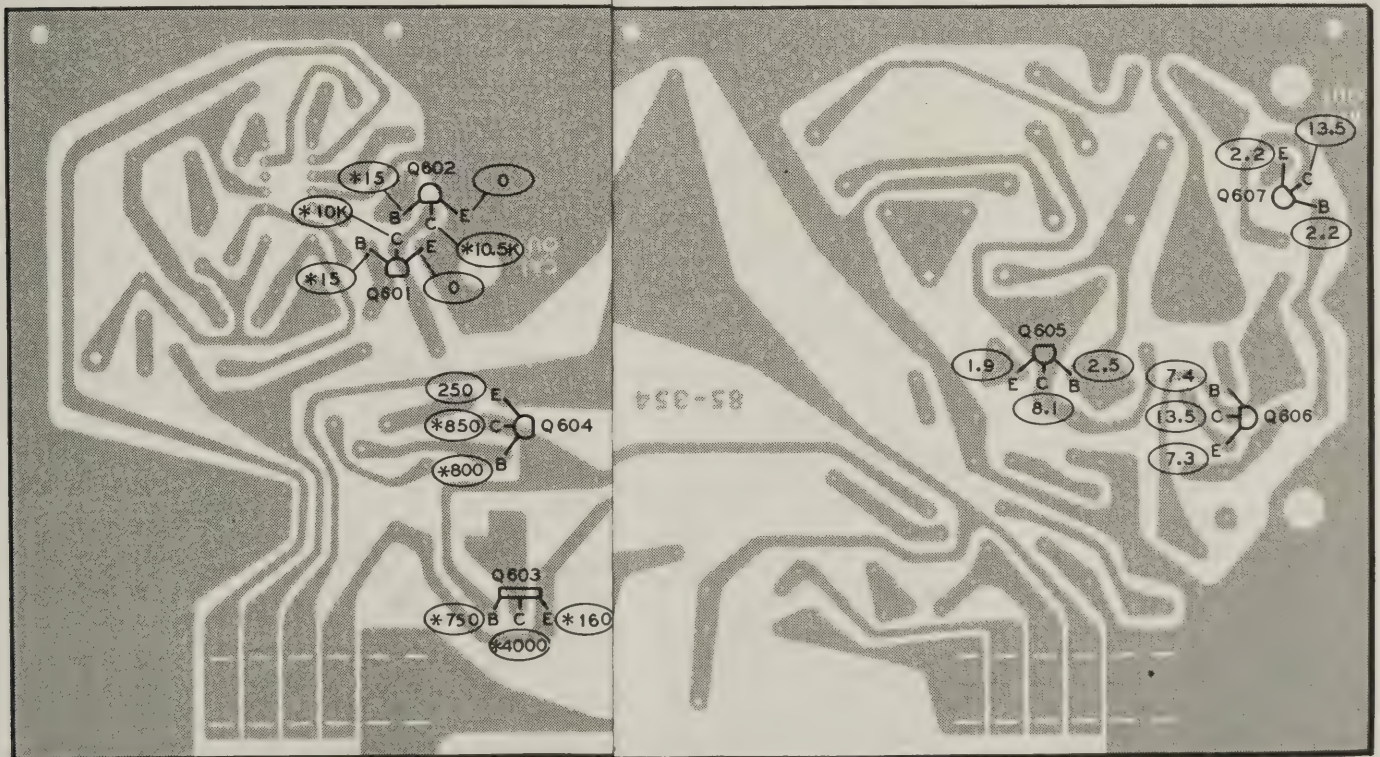
IF/AUDIO CIRCUIT BOARD SCHEMATIC

Low Z_{in}

RESISE CHARTS



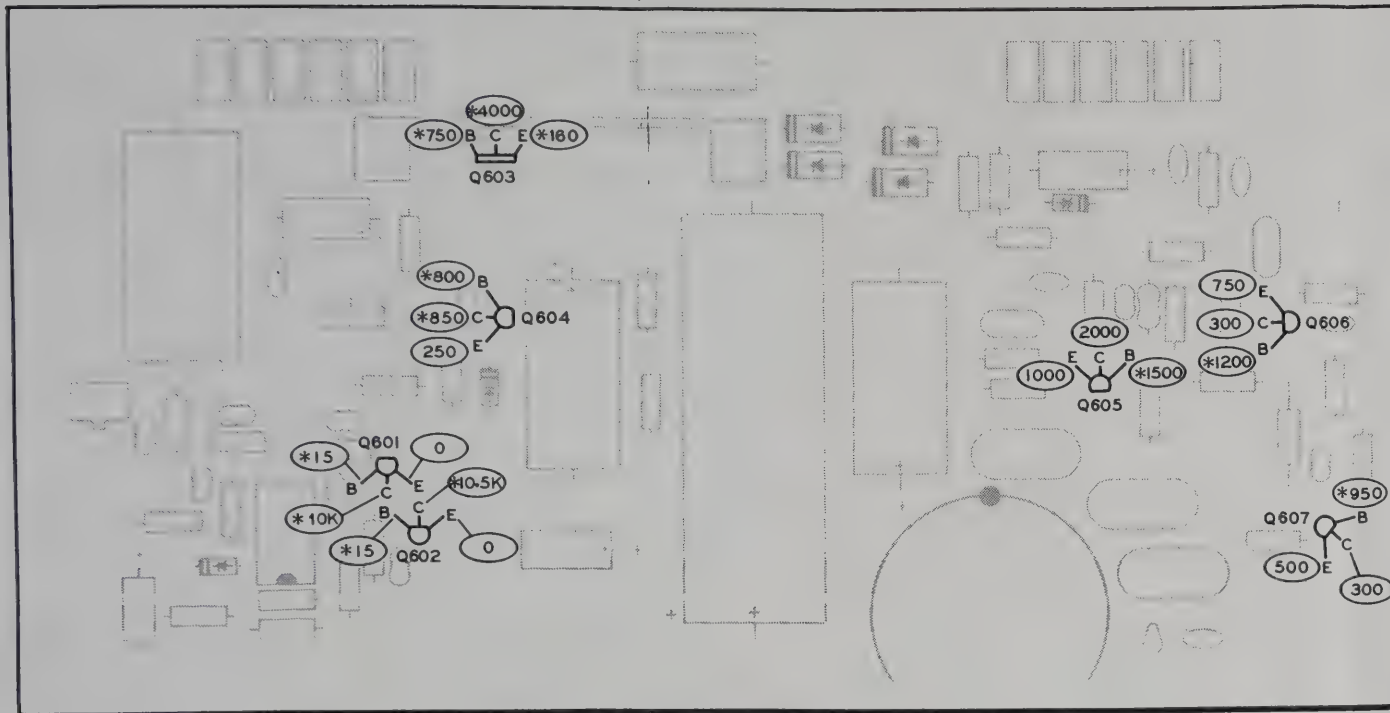
(SH COMPONENT SIDE)



* FORWARD BIASED DIODE OR TRANSISTOR JUNC
MAKES READING DEPENDENT ON OHMMETER RAN (SH
(SH

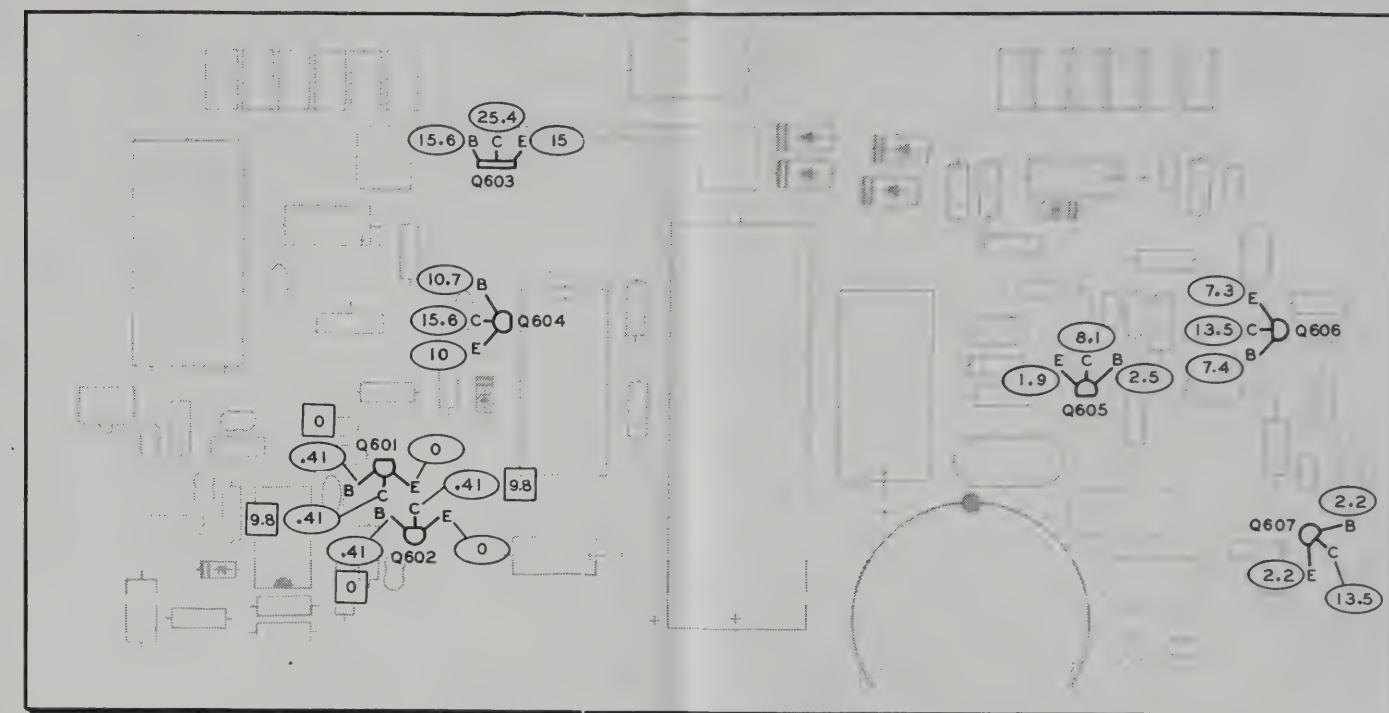
DM FOIL SIDE)

RESISTANCE CHARTS

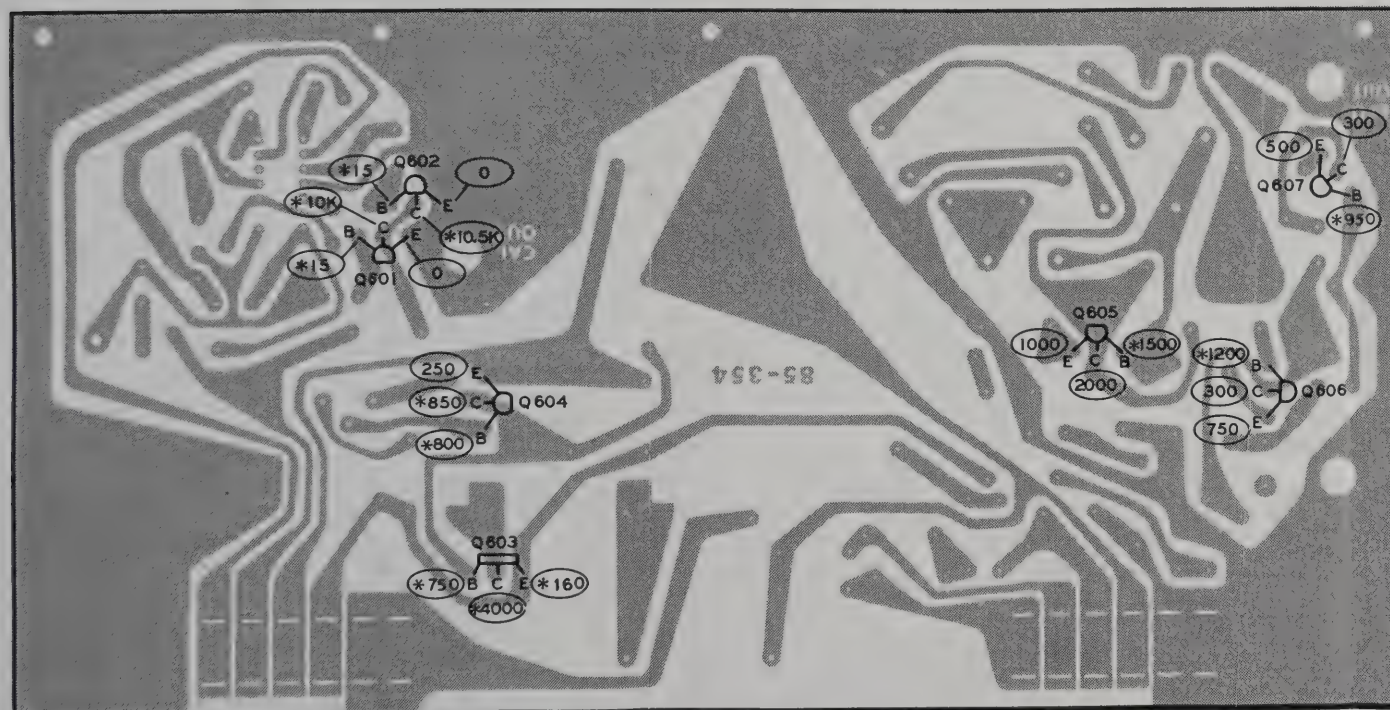


(SHOWN FROM COMPONENT SIDE)

VOLTAGE CHARTS

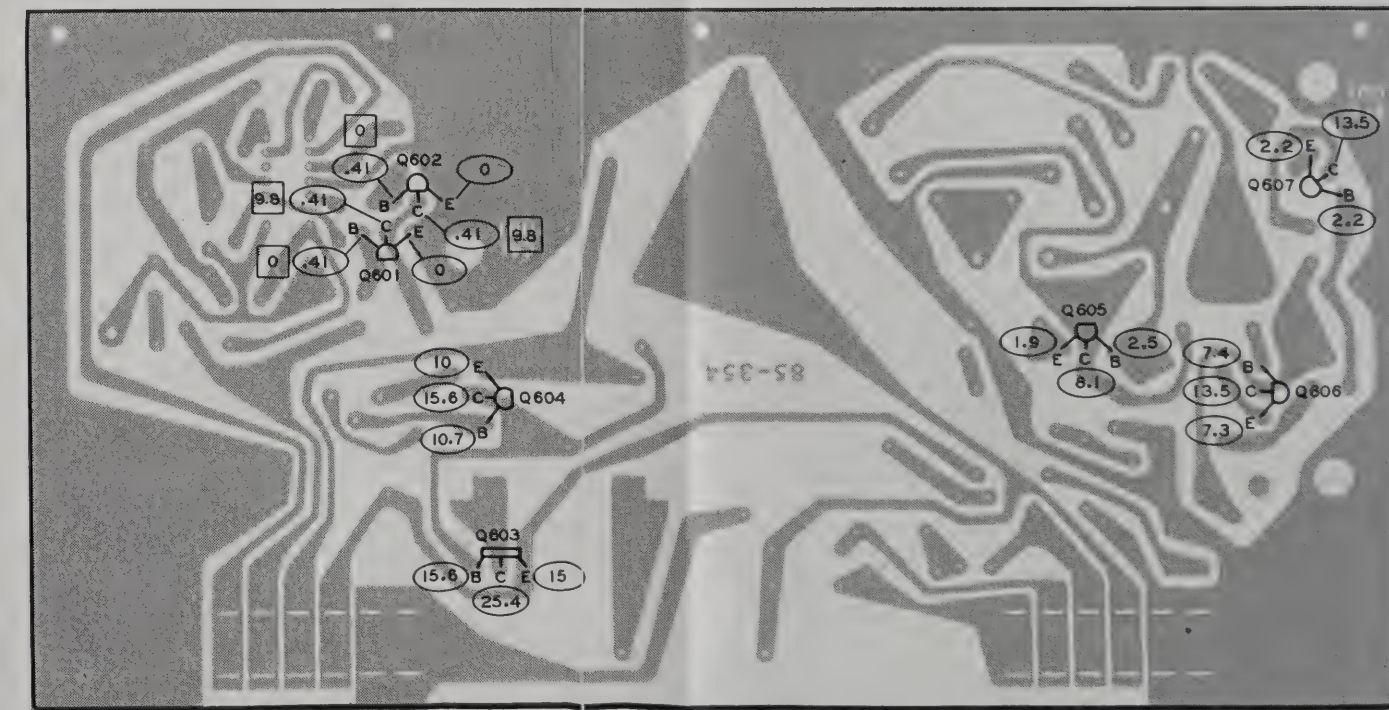


(SHOWN FROM COMPONENT SIDE)



* FORWARD BIASED DIODE OR TRANSISTOR JUNCTION
MAKES READING DEPENDENT ON OHMMETER RANGE.

(SHOWN FROM FOIL SIDE)



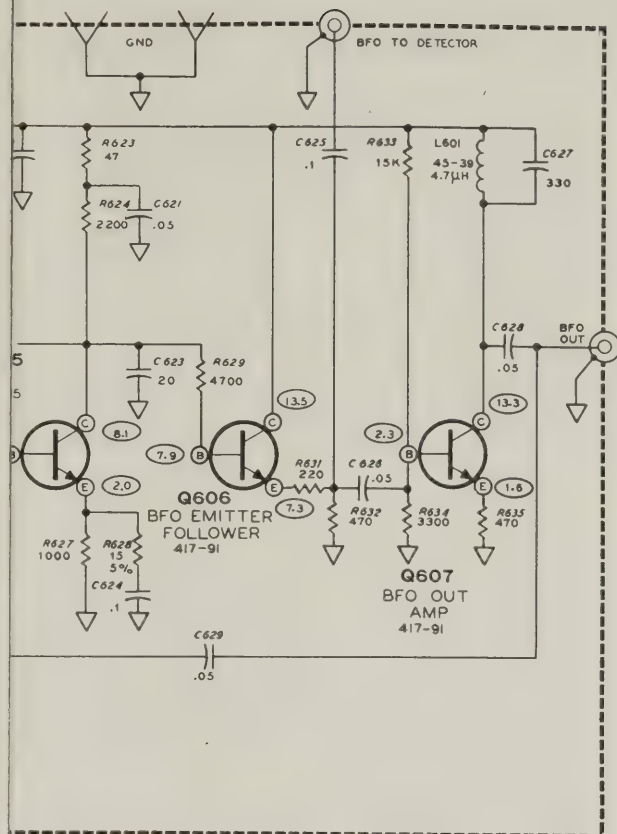
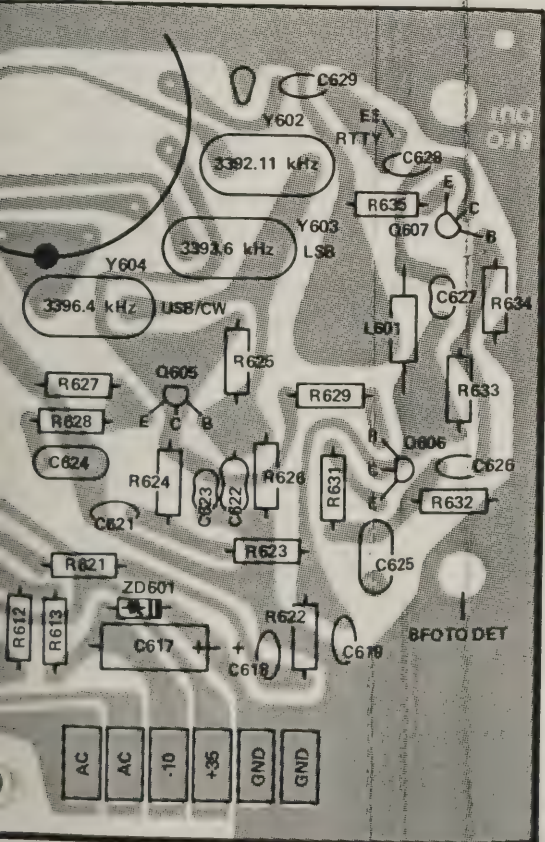
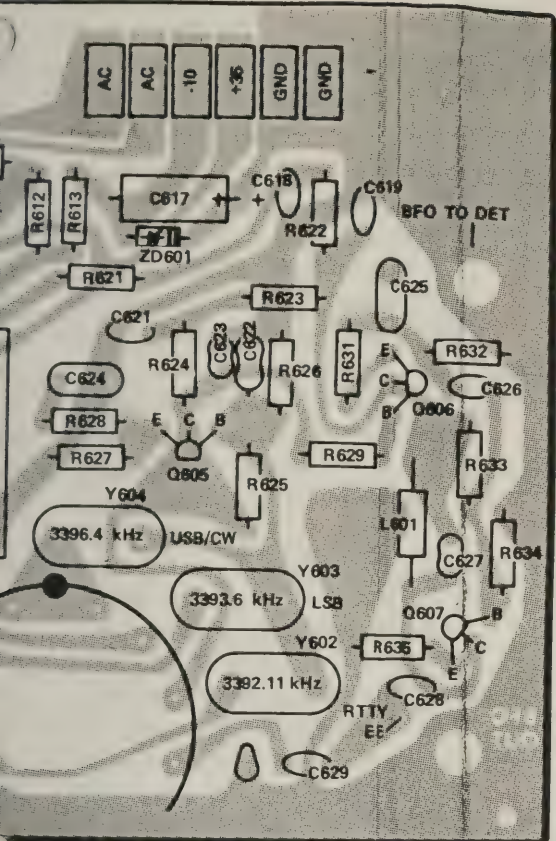
○ CALIBRATOR IN OFF POSITION
□ CALIBRATOR IN ON POSITION

(SHOWN FROM FOIL SIDE)

POWER SUPPLY/BFO CIRCUIT BOARD

TROUBLESHOOTING CHART

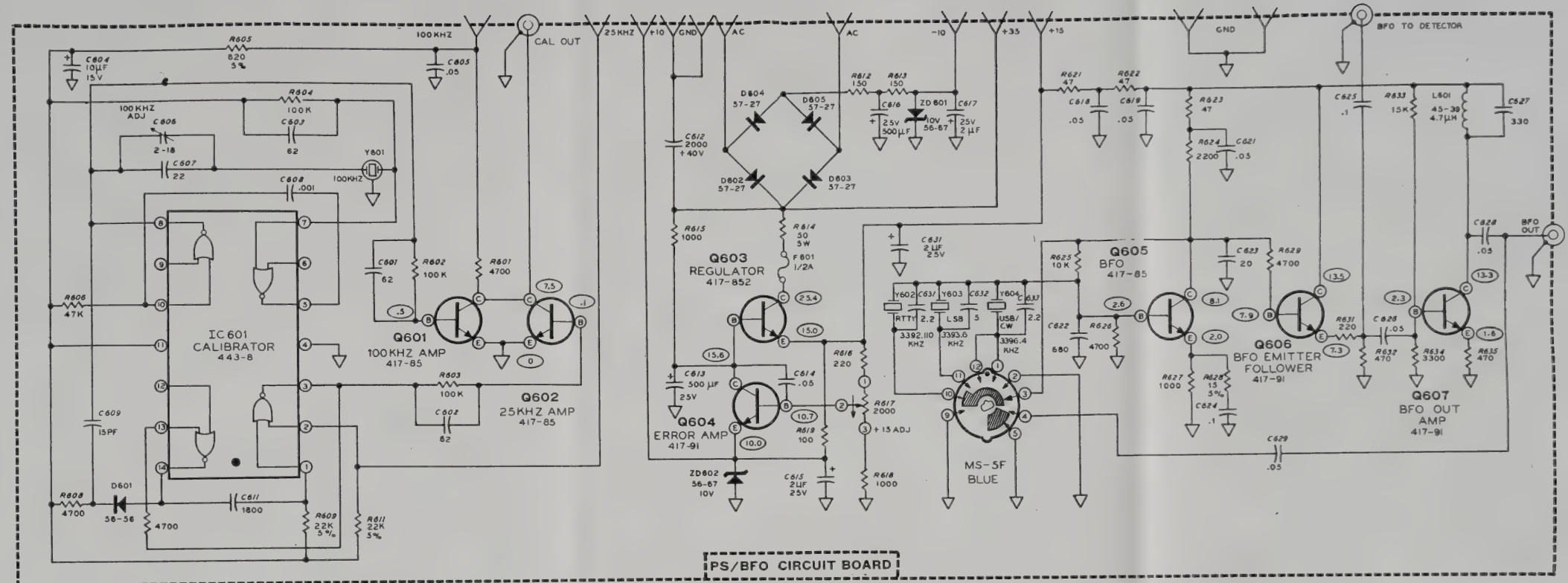
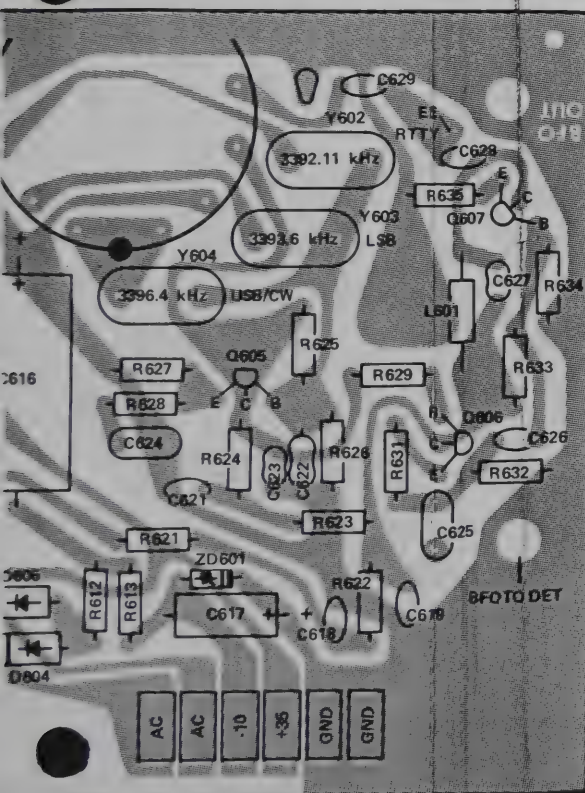
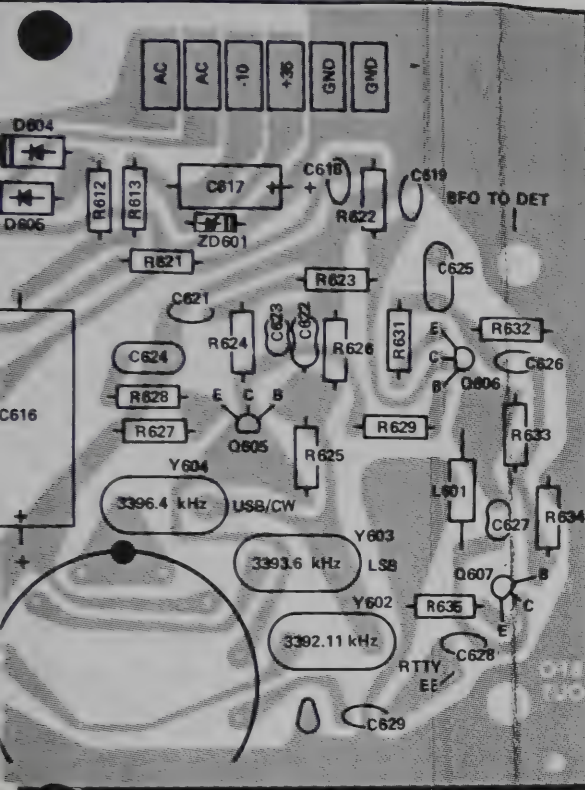
SYMPTOM	POSSIBLE CAUSE
BFO does not operate.	1. Rotor in switch wafer MS-5 of the MODE switch turned 180 degrees from its correct position. 2. Transistor Q605, Q606 or Q607 incorrectly installed or shorted. 3. Crystal Y602, Y603 or Y604 defective.
Calibrator does not operate.	1. IC-601 installed incorrectly or shorted. 2. Crystal Y601 defective. 3. Capacitor C605 shorted. 4. Shielded cable not connected to BFO OUT jack. 5. Diode D601 installed backward or shorted. 6. Transistor Q601 or Q602 installed incorrectly or shorted. 7. Resistor R609 or capacitor C611 or C603 improper value or shorted.
+35-volt power supply voltage incorrect.	1. Diode D602 or D603 installed backward or shorted. 2. Capacitor C612 shorted.
+15-volt power supply voltage incorrect.	1. +35 volts not present. 2. Resistor R617 open or incorrectly adjusted. 3. Zener diode ZD602 installed backward or shorted. 4. Capacitor C613 shorted. 5. +15-volt line shorted. 6. +10-volt line shorted.
+10-volt power supply voltage incorrect.	1. +35 volts not present. 2. Zener diode ZD602 installed backward or shorted. 3. +10-volt line shorted. 4. Resistor R619 open.
-10-volt power supply voltage incorrect.	1. Diode D604, D605 or ZD601 installed backward or shorted. 2. Capacitor C616 or C617 reversed or shorted. 3. -10-volt line shorted.



TIC

THEORY OF THE EARTH

THEORY OF THE EARTH	
1. The Earth is a sphere.	2. The Earth is composed of different layers.
3. The Earth is covered by a thin layer of water.	4. The Earth is covered by a thin layer of air.
5. The Earth is covered by a thin layer of soil.	6. The Earth is covered by a thin layer of vegetation.
7. The Earth is covered by a thin layer of animals.	8. The Earth is covered by a thin layer of humans.
9. The Earth is covered by a thin layer of plants.	10. The Earth is covered by a thin layer of minerals.
11. The Earth is covered by a thin layer of rocks.	12. The Earth is covered by a thin layer of fossils.
13. The Earth is covered by a thin layer of bones.	14. The Earth is covered by a thin layer of shells.
15. The Earth is covered by a thin layer of teeth.	16. The Earth is covered by a thin layer of hair.
17. The Earth is covered by a thin layer of skin.	18. The Earth is covered by a thin layer of muscles.
19. The Earth is covered by a thin layer of nerves.	20. The Earth is covered by a thin layer of blood.
21. The Earth is covered by a thin layer of organs.	22. The Earth is covered by a thin layer of systems.
23. The Earth is covered by a thin layer of functions.	24. The Earth is covered by a thin layer of processes.
25. The Earth is covered by a thin layer of structures.	26. The Earth is covered by a thin layer of components.
27. The Earth is covered by a thin layer of parts.	28. The Earth is covered by a thin layer of elements.
29. The Earth is covered by a thin layer of atoms.	30. The Earth is covered by a thin layer of molecules.
31. The Earth is covered by a thin layer of cells.	32. The Earth is covered by a thin layer of tissues.
33. The Earth is covered by a thin layer of organs.	34. The Earth is covered by a thin layer of systems.
35. The Earth is covered by a thin layer of functions.	36. The Earth is covered by a thin layer of processes.
37. The Earth is covered by a thin layer of structures.	38. The Earth is covered by a thin layer of components.
39. The Earth is covered by a thin layer of parts.	40. The Earth is covered by a thin layer of elements.
41. The Earth is covered by a thin layer of atoms.	42. The Earth is covered by a thin layer of molecules.
43. The Earth is covered by a thin layer of cells.	44. The Earth is covered by a thin layer of tissues.
45. The Earth is covered by a thin layer of organs.	46. The Earth is covered by a thin layer of systems.
47. The Earth is covered by a thin layer of functions.	48. The Earth is covered by a thin layer of processes.
49. The Earth is covered by a thin layer of structures.	50. The Earth is covered by a thin layer of components.
51. The Earth is covered by a thin layer of parts.	52. The Earth is covered by a thin layer of elements.
53. The Earth is covered by a thin layer of atoms.	54. The Earth is covered by a thin layer of molecules.
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57. The Earth is covered by a thin layer of organs.	58. The Earth is covered by a thin layer of systems.
59. The Earth is covered by a thin layer of functions.	60. The Earth is covered by a thin layer of processes.
61. The Earth is covered by a thin layer of structures.	62. The Earth is covered by a thin layer of components.
63. The Earth is covered by a thin layer of parts.	64. The Earth is covered by a thin layer of elements.
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69. The Earth is covered by a thin layer of organs.	70. The Earth is covered by a thin layer of systems.
71. The Earth is covered by a thin layer of functions.	72. The Earth is covered by a thin layer of processes.
73. The Earth is covered by a thin layer of structures.	74. The Earth is covered by a thin layer of components.
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83. The Earth is covered by a thin layer of functions.	84. The Earth is covered by a thin layer of processes.
85. The Earth is covered by a thin layer of structures.	86. The Earth is covered by a thin layer of components.
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93. The Earth is covered by a thin layer of organs.	94. The Earth is covered by a thin layer of systems.
95. The Earth is covered by a thin layer of functions.	96. The Earth is covered by a thin layer of processes.
97. The Earth is covered by a thin layer of structures.	98. The Earth is covered by a thin layer of components.
99. The Earth is covered by a thin layer of parts.	100. The Earth is covered by a thin layer of elements.



PS/BFO CIRCUIT BOARD SCHEMATIC

CIRCUIT BOARD

ROOTING CHART

POSSIBLE CAUSE

1. Rotor in switch wafer MS-5 of the MODE switch turned 180 degrees from its correct position.
2. Transistor Q605, Q606 or Q607 incorrectly installed or shorted.
3. Crystal Y602, Y603 or Y604 defective.

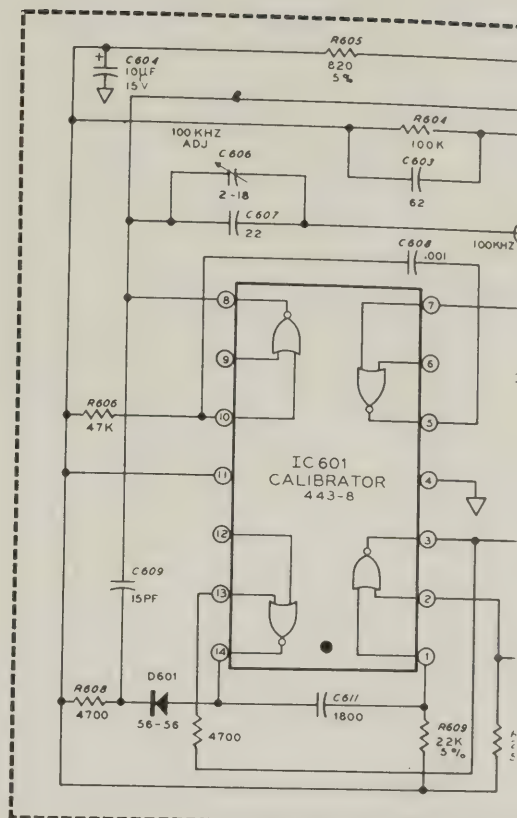
1. IC-601 installed incorrectly or shorted.
2. Crystal Y601 defective.
3. Capacitor C605 shorted.
4. Shielded cable not connected to BFO OUT jack.
5. Diode D601 installed backward or shorted.
6. Transistor Q601 or Q602 installed incorrectly or shorted.
7. Resistor R609 or capacitor C611 or C603 improper value or shorted.

1. Diode D602 or D603 installed backward or shorted.
- Capacitor C612 shorted.

1. +35 volts not present.
2. Resistor R617 open or incorrectly adjusted.
3. Zener diode ZD602 installed backward or shorted.
4. Capacitor C613 shorted.
5. +15-volt line shorted.
6. +10-volt line shorted.

1. +35 volts not present.
2. Zener diode ZD602 installed backward or shorted.
3. +10-volt line shorted.
4. Resistor R619 open.

1. Diode D604, D605 or ZD601 installed backward or shorted.
2. Capacitor C616 or C617 reversed or shorted.
3. -10-volt line shorted.



CIRCUIT BOARD

TROUBLESHOOTING CHART

POSSIBLE CAUSE

1. Rotor in switch wafer MS-5 of the MODE switch turned 180 degrees from its correct position.
2. Transistor Q605, Q606 or Q607 incorrectly installed or shorted.
3. Crystal Y602, Y603 or Y604 defective.

1. IC-601 installed incorrectly or shorted.
2. Crystal Y601 defective.
3. Capacitor C605 shorted.
4. Shielded cable not connected to BFO OUT jack.
5. Diode D601 installed backward or shorted.
6. Transistor Q601 or Q602 installed incorrectly or shorted.
7. Resistor R609 or capacitor C611 or C603 improper value or shorted.

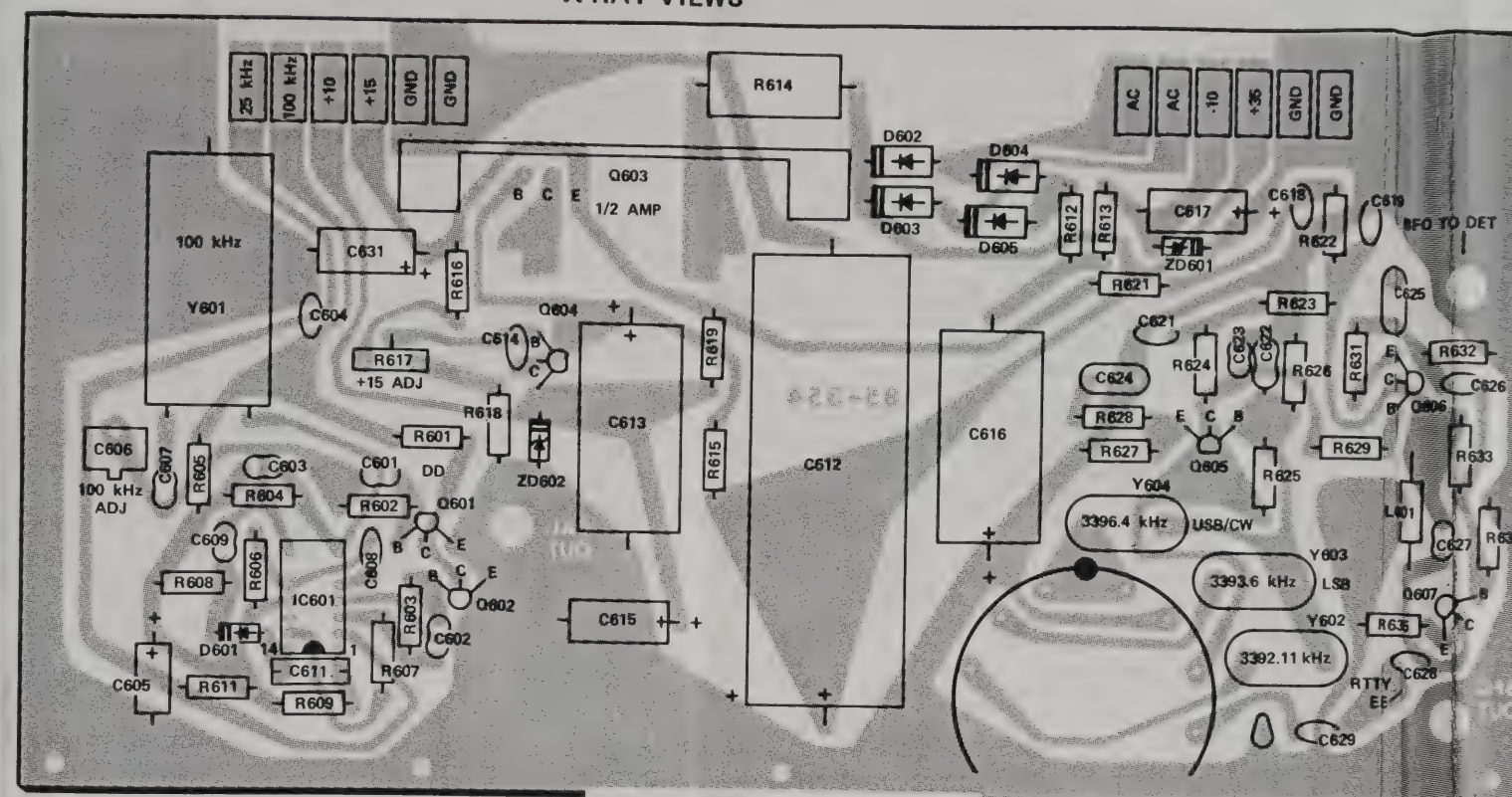
1. Diode D602 or D603 installed backward or shorted.
2. Capacitor C612 shorted.

1. +35 volts not present.
2. Resistor R617 open or incorrectly adjusted.
3. Zener diode ZD602 installed backward or shorted.
4. Capacitor C613 shorted.
5. +15-volt line shorted.
6. +10-volt line shorted.

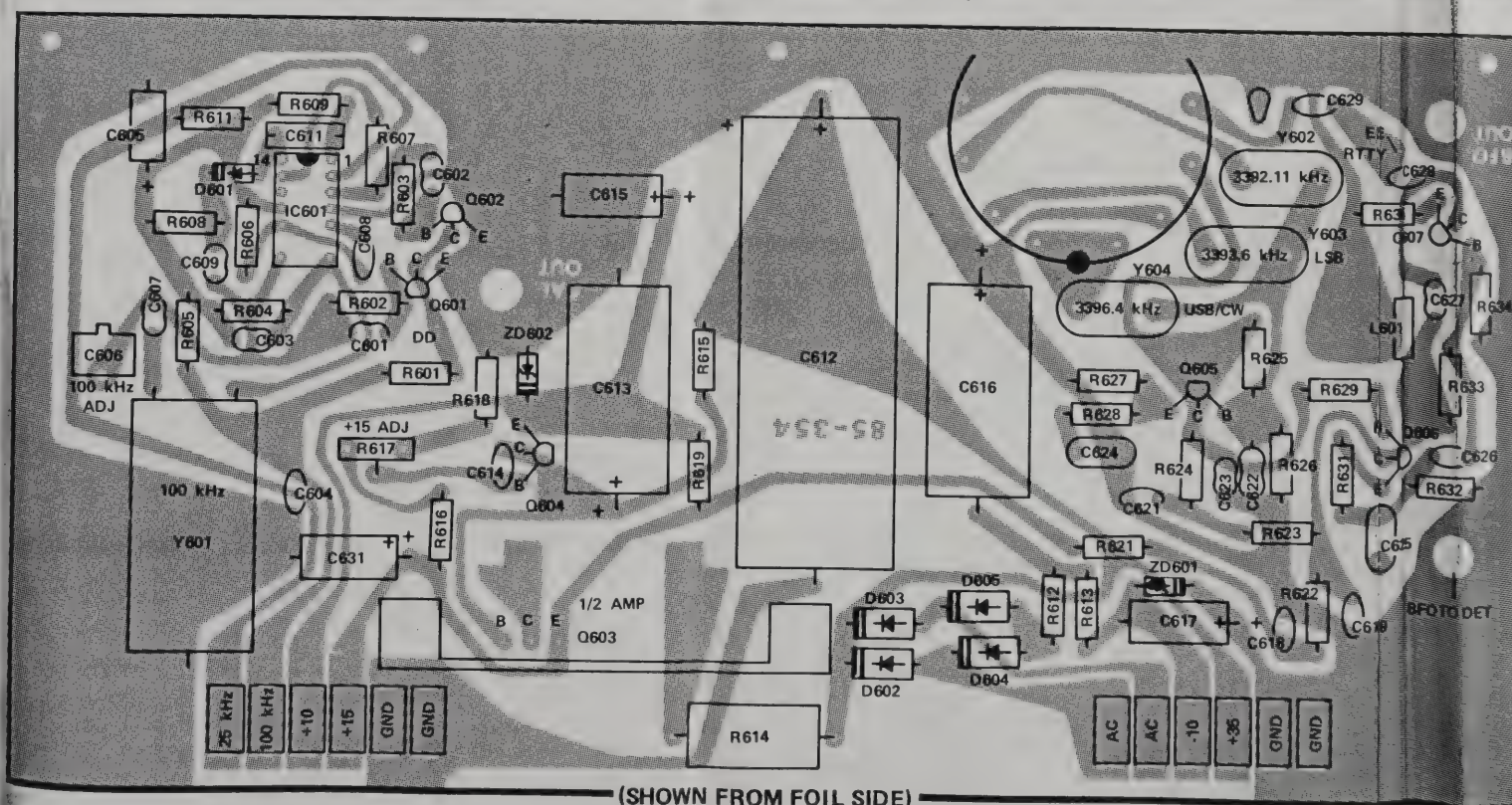
1. +35 volts not present.
2. Zener diode ZD602 installed backward or shorted.
3. +10-volt line shorted.
4. Resistor R619 open.

1. Diode D604, D605 or ZD601 installed backward or shorted.
2. Capacitor C616 or C617 reversed or shorted.
3. -10-volt line shorted.

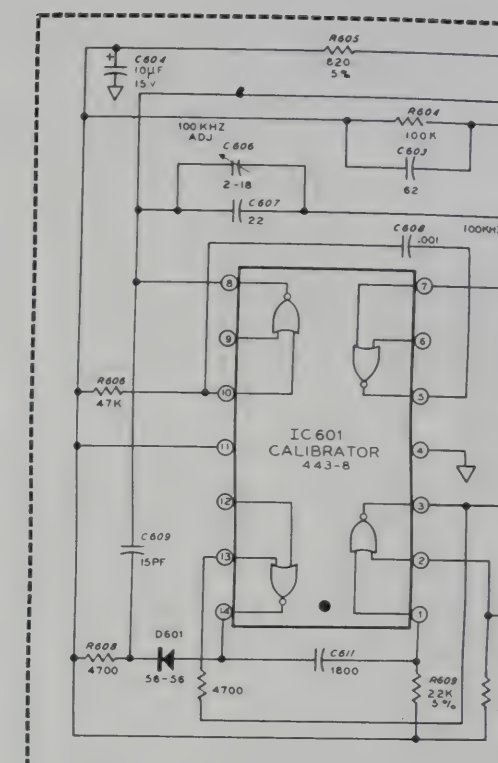
X-RAY VIEWS

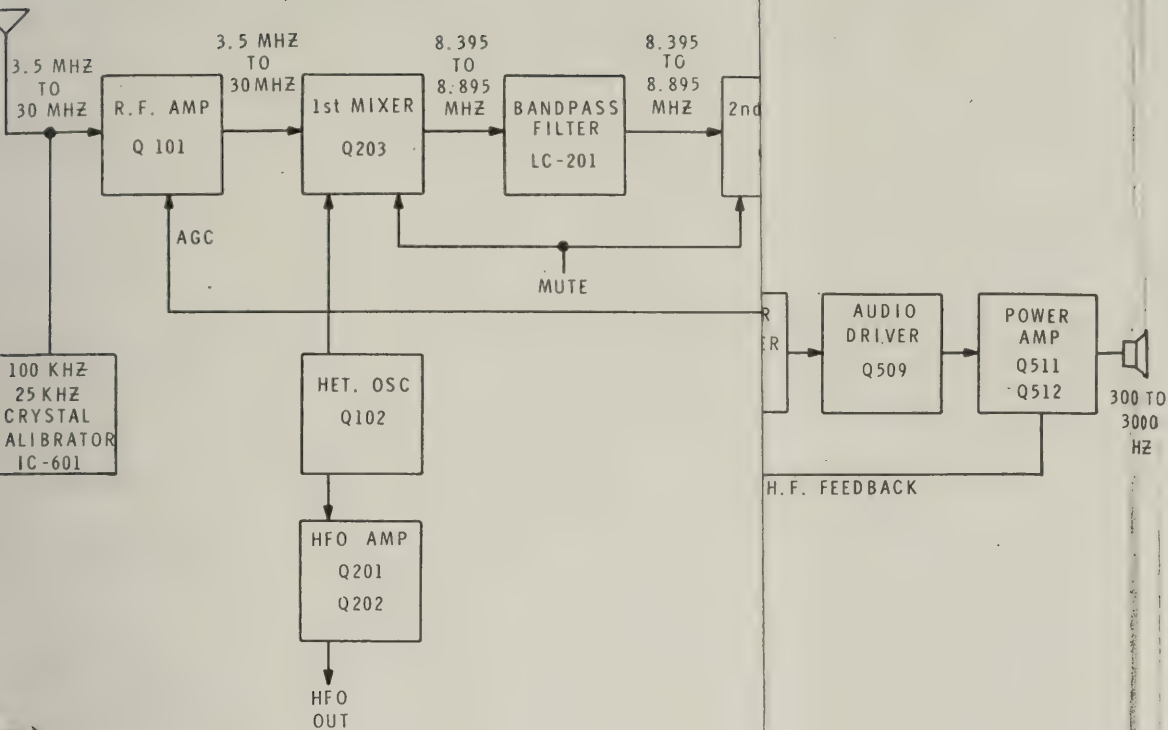


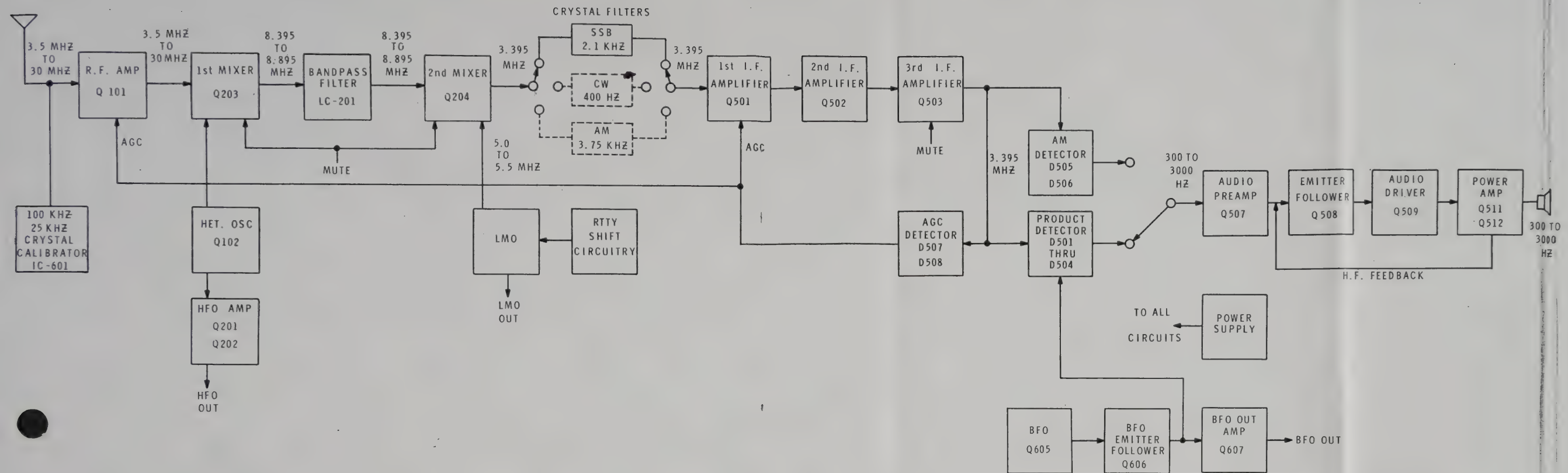
(SHOWN FROM COMPONENT SIDE)



(SHOWN FROM FOIL SIDE)







BLOCK DIAGRAM

SPECIFICATIONS

Frequency Range (Megahertz)	3.5 to 4.0, 700 to 7.3, 14.0 to 14.5, 15.0 to 15.3, 21.0 to 21.5, 28.0 to 30.
Intermediate Frequency (IF)	3.395 MHz.
Frequency Stability	Less than 100 Hz per hour after 10 minutes warmup under normal ambient conditions. Less than 100 Hz drift for $\pm 10\%$ line voltage variation.
Frequency Selection	Build-in LMO (Linear Master Oscillator).
Modes of Operations	
SSB	Single sideband (suppressed carrier, with selectable upper or lower sideband).
CW	Keyed continuous wave.
AM	Amplitude modulated continuous wave.
RTTY	Radio Teletype (frequency-shift keyed continuous wave). Wide shift, narrow shift, and narrow CW shift identification.
Sensitivity	Less than 0.25 microvolt for 10 dB signal-plus-noise to noise ratio for SSB operation.
Overall Gain	Less than 1.5 microvolt input for 0.5 watts audio output (single tone SSB).
AGC Characteristic	
Blocking	Greater than 3.0 V CW/SSB/RTTY.
Dynamic Range	Greater than 150 dB CW/SSB.
RF Attenuator Range	0-40 dB nominal.

Selectivity

SSB	2.1 kHz 6 dB down, 5.0 kHz maximum at 60 dB down (crystal filter supplied).
CW	400 Hz at 6 dB down, 2.0 kHz maximum at 60 dB down (crystal filter available as an accessory).
AM	3.75 kHz at 6 dB down, 10 kHz maximum at 60 dB down (crystal filter available as an accessory).
RTTY	2.1 kHz at 6 dB down, 5.0 kHz maximum at 60 dB down (uses SSB crystal filter).

Image Rejection 60 dB or better.

IF Rejection

3.395	Greater than 55 dB.
8.595	Greater than 50 dB.

Spurious Response All below 1 microvolt equivalent signal input.

Temperature Range 10°C to 50°C ambient.

Dial Accuracy

Electrical	Within 400 Hz after calibration at nearest 100 kHz or 25 kHz point.
Visual	Within 200 Hz.

Variation in RTTY shift as LMO frequency is changed (shift can be adjusted to nominal value at any point within the band).

CW Shift (50 Hz nominal)	Less than 10 Hz/100 kHz.
Narrow Shift (170 Hz nominal)	Less than 20 Hz/100 kHz.
Wide Shift (850 Hz nominal)	Less than 100 Hz/100 kHz.

Calibration Every 100 kHz or 25 kHz.

Dial Backlash No more than 50 Hz.

Antenna Input Impedance 50 Ω nominal unbalanced.

Audio Response

SSB	350 to 2450 Hz nominal at 6 dB.
CW (with accessory filter)	800 to 1200 Hz nominal at 6 dB.
AM (with accessory filter)	200 to 3500 Hz nominal at 6 dB.
RTTY	1840 to 3940 Hz nominal at 6 dB.

Audio Output Impedance

Matching Speaker	8 Ω .
Matching Headphones	Low impedance.

Audio Output Power	4 watts at less than 10% distortion.
------------------------------	--------------------------------------

Muting	Open external ground at Mute socket.
------------------	--------------------------------------

Power Requirements	105 to 130 or 210 to 260 volt ac, 40 watts maximum.
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Controls

Front Panel	Main Tuning dial. Function switch. Mode switch. Band switch. AGC switch. Converter switch. AF Gain control/Power on-off. RF Gain/Speaker Disable. Preselector. RF Attenuator.
-----------------------	--

Circuit Boards

IF/Audio	Bias adjust. Meter zero. Meter full scale.
PS/BFO	+15 V adjust. 100 kHz adjust.
RTTY	Wide shift. Narrow shift. CW shift.

Connections

Rear Panel	Phones. HF Antenna. VHF Antenna #1. VHF Antenna #2. Mute. Anti-Vox. Speaker. HFO out. LMO out. BFO out. CW shift. 4-Spare sockets. 3-Wire line cord socket. Accessory Socket (RTTY and VHF converter connections).
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NOTE: Specifications measured with 120 Vac line voltage at 25° C.

Cabinet Dimensions	12-1/4" wide x 6-5/8" high x 13" deep.
Overall Dimensions (with knobs and feet installed)	12-1/4" wide x 7-15/16" high x 14" deep.
Net Weight	15-3/4 lbs.



The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

The Circuit Description is provided to give you a better understanding of what is happening in each stage of your Receiver. Refer to the Block Diagram (fold-out from Page 160) and the Schematic Diagram (fold-out from Page 173) when reading this Circuit Description.

Letter number designations for the resistors, capacitors, and other components are placed in the following groups to make it easier to locate parts on the Schematic and on the chassis.

101 to 199	Parts mounted on the antenna, RF amplifier, heterodyne oscillator, and crystal Switch-Boards.
201 to 299	Parts mounted on the mixer circuit board.
301 to 399	Parts mounted on the RTTY circuit board.
501 to 599	Parts mounted on the IF/audio circuit board.
601 to 699	Parts mounted on the power supply/BFO circuit board.
701 to 799	Parts mounted on the chassis.

GENERAL

Signals are received by the antenna and coupled through the Band switch and the antenna tuned circuits on the antenna Switch-Board to the RF amplifier Switch-Board. Here the signal is amplified by FET Q101 and then coupled to the mixer circuit board. The signal is mixed in the first mixer FET Q203, with a signal from the oscillator Switch-Board. This mixing produces an 8.395 MHz to 8.895 MHz frequency which is coupled through bandpass filter LC201 to the second mixer FET Q204.

A signal produced by the LMO (linear master oscillator) is mixed with the 8.395 MHz signal in the second mixer to produce a 3.395 MHz IF signal. The IF signal is then connected from the mixer circuit board, through the Mode switch and crystal filter, to the IF/audio circuit board.

The IF signal is amplified by Q501, Q502, and Q503. The signal is then coupled to either the product detector, or the AM detector, depending on the mode of operation, where it is detected.

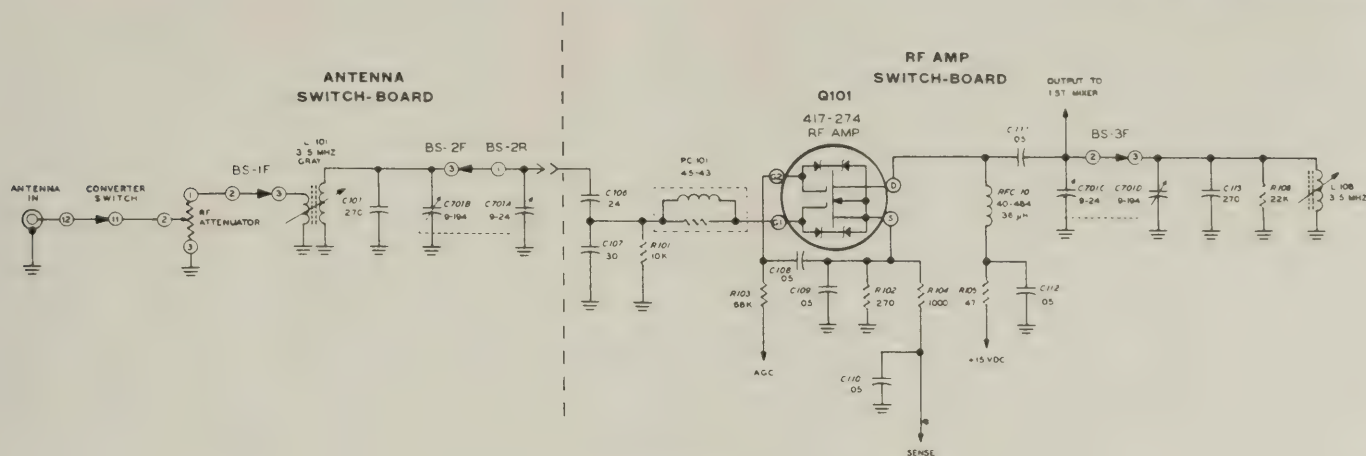
The detected audio signal is amplified by transistors Q507, Q508, Q509, Q511, and Q512. The resulting audio output is then connected to the Phones jack, the Anti-VOX jack, and through the Speaker Disable switch to the Speaker jack.

On the following pages, each circuit will be described in detail. The circuits will be described as they would operate in the Receiver under normal signal conditions with the Mode switch in the USB position, the Function switch in the Operate position, and the Band switch in the 3.5 position.

ANTENNA TUNING CIRCUITS

Signals from the antenna input jack are coupled through the converter switch to the RF attenuator. This control reduces the amplitude of the incoming signal before it reaches the RF amplifier circuits. The receiver then is able to handle very strong signals without overloading. If the receiver is being overloaded by a strong signal adjacent to a desired weak signal, the readability of the weak signal can be improved by increasing the RF attenuation.

Signals are then coupled through band-switch wafer BS-IF to a tuned circuit consisting of coil L101 and capacitors C101,



when the mute circuit is closed, to permit normal operation. When the mute circuit is opened, a positive voltage back biases diode D201 and causes Q203 to cut off.

SECOND MIXER CIRCUIT

The 8.595 MHz signal from bandpass filter LC-201 is coupled through capacitor C211 to gate G1 of FET Q204. A 5.200 MHz signal from the LMO* (linear master oscillator) is coupled through resistor R215 and capacitor C214 to gate G2 of Q204. These two signals are mixed to produce sum and difference frequencies (13.795 MHz and 3.395 MHz) at the drain (D) of Q204. A tuned circuit consisting of coil L202 and capacitors C216 and C217 is tapped to provide the required 2000 Ω source impedance to the crystal filter.

Resistors R216, R217, R218, R219, and R221 bias Q204. Capacitor C212 couples the 5.200 MHz signal from the LMO to the LMO Out jack for external use. Source (S) current is coupled through diode D202 to ground when the mute circuit is closed to permit normal operation. When the mute circuit is opened, a positive voltage back biases diode D202 and causes Q204 to cut off.

***NOTE:** The LMO output frequency increases as the frequency of the incoming signal decreases. For example: when the Receiver is tuned to 3.5 MHz, the LMO output frequency is 5.5 MHz; when the Receiver is tuned to 4.0 MHz, the LMO output frequency is 5.0 MHz.

LMO

The LMO is a sealed unit containing a capacity-tuned silicon transistor oscillator and a transistor bandpass amplifier. (Since internal circuitry may vary between units due to temperature compensation, a schematic of this circuit is not included.) The tuning capacitor is factory-adjusted to provide a linear frequency change with dial rotation, giving

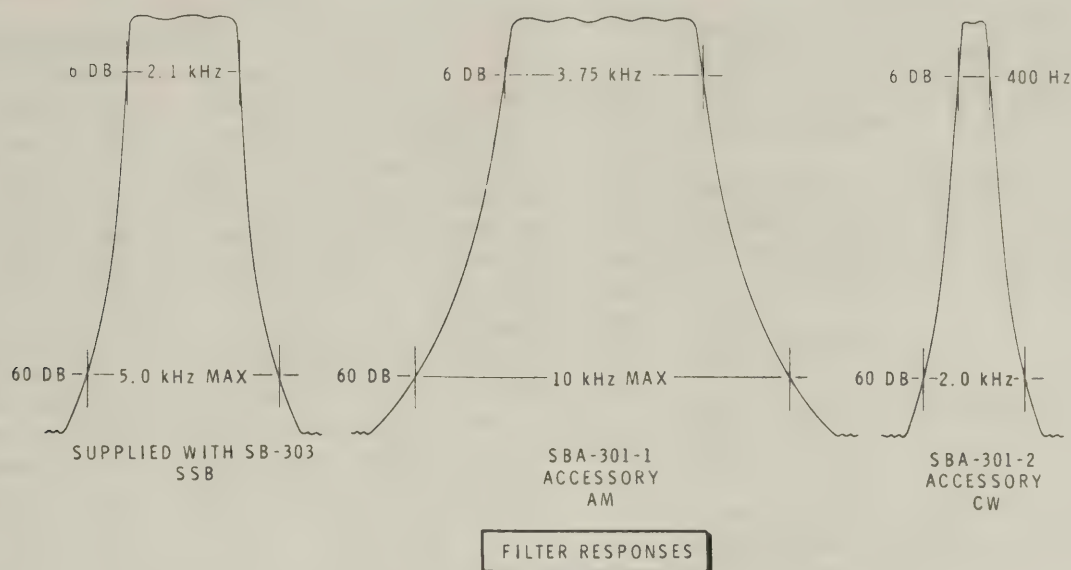


Figure 32

100 kHz change per turn of the shaft between 5 and 5.5 MHz.

To provide the same dial reading in both USB and LSB, the LMO frequency must be shifted 2.8 kHz by the Mode switch. When a positive voltage is applied to the shift bias terminal (in LSB), it causes a switching diode to conduct, changing inductance in the oscillator circuit and causing a 2.8 kHz frequency change in the LMO. A negative voltage (in USB and CW) will open the diode switch, shifting the frequency to the correct operating point for LSB operation. This operating point can be adjusted by the sideband shift adjustment on top of the LMO.

CRYSTAL FILTERS

The 13.795 MHz and 3.395 MHz signals are coupled through mode switch wafer MS-1F to the 2.1 kHz crystal filter. The 13.795 MHz signal is rejected by this filter, which allows only the 3.395 MHz signal to pass. Mode switch wafers MS-2R and MS-2F couple this signal to the IF circuit.

This Receiver is supplied with a 2.1 kHz SSB crystal filter. The sharp selectivity provided by this filter permits excellent rejection of unwanted adjacent signals. A 3.75 MHz AM filter and a 400 Hz CW filter are available as optional accessories. The filter responses are shown in Figure 32.

IF CIRCUITS

The 3.395 MHz signal is coupled from the IF input, through capacitor C501 and resistor R502, to gate G1 of FET Q501. The signal is amplified and coupled from the drain (D) of Q501, through resistor R506, through IF transformer T501, to the base of transistor Q502. Transformer T501 provides

correct impedance matching between FET Q501 and transistor Q502. The signal is amplified again by Q502 and coupled through resistor R511 and IF transformer T502 to the base of transistor Q503. Transformer T502 provides impedance matching between transistor Q502 and Q503. The signal is amplified again by transistor Q503 and coupled through resistor R515 to IF transformer T503.

Power is supplied to the IF circuits through resistors R517, R516, and RF choke RFC501.

AM DETECTOR

From the primary winding of transformer T503, and 3.395 MHz signal is coupled through capacitor C516 to the AM detector. Here the signal is detected by diodes D505 and D506 and filtered by capacitor C515. The detected audio is coupled through mode switch MS-4F to AF Gain control R703.

PRODUCT DETECTOR

The 3.395 MHz signal is coupled from the secondary of transformer T503 to resistors R520 and R519 and to detector diodes D501, D502, D503, and D504. A signal from the BFO (beat frequency oscillator) is coupled to the junction of resistors R519 and R520. When the BFO signal goes positive, diodes D501 and D503 conduct. When the BFO signal goes negative, diodes D502 and D504 conduct. The result is a "chopping" of the 3.395 MHz signal at a rate equal to the BFO frequency. This produces signals that are equal to the sum and difference of the 3.395 MHz and BFO signals. The higher of these two frequencies is filtered by capacitor C513 and C514 and resistor R521. The lower frequency is the detected audio which is coupled through mode switch wafer MS-4F to AF Gain control R703.

AUDIO CIRCUITS

Audio is coupled from AF Gain control R703 through capacitor C524 to the base of transistor Q507. Audio preamplifier transistor Q507 presents a high input impedance to the detectors because of unbypassed emitter resistor R549. The amplified signal from the collector of Q507 is direct coupled to emitter follower transistor Q508. This transistor has a low output impedance which is needed to drive audio driver transistor Q509. The amplified signal from Q509 is direct coupled to the base of transistor Q511 and coupled through diode D511 and resistor R556 to the base of transistor Q512. Transistors Q511 and Q512 form a push-pull complementary output amplifier. On positive half cycles of the signal transistor Q512 conducts, and on negative half cycles transistor Q511 conducts.

Resistor R554 couples negative feedback to the base of transistor Q509. At frequencies above 3000 Hz, capacitor C526 couples negative feedback to the base of transistor Q508.

Diode D511 is mounted on the same heat sink as Q511 and Q512. Therefore, the voltage drop across this diode will vary with the temperature of the heat sink to compensate for changes in the operating point of Q511 and Q512.

Capacitor C529 is a "bootstrap" capacitor which provides feedback to transistor Q511 and Q512. This feedback keeps the supply voltage constant to the transistors, which reduces distortion at high volume levels.

AGC CIRCUIT

Refer to Figure 33 for a simplified schematic of the AGC circuit.

From the primary of transformer T503, the 3.395 MHz signal is coupled through capacitor C517 to the AGC detector. Diodes D507 and D508 rectify the signal to produce a dc AGC voltage which is filtered by capacitor C519. The AGC voltage is fed directly to the AGC switch as fast AGC. The fast AGC is coupled from the AGC switch to

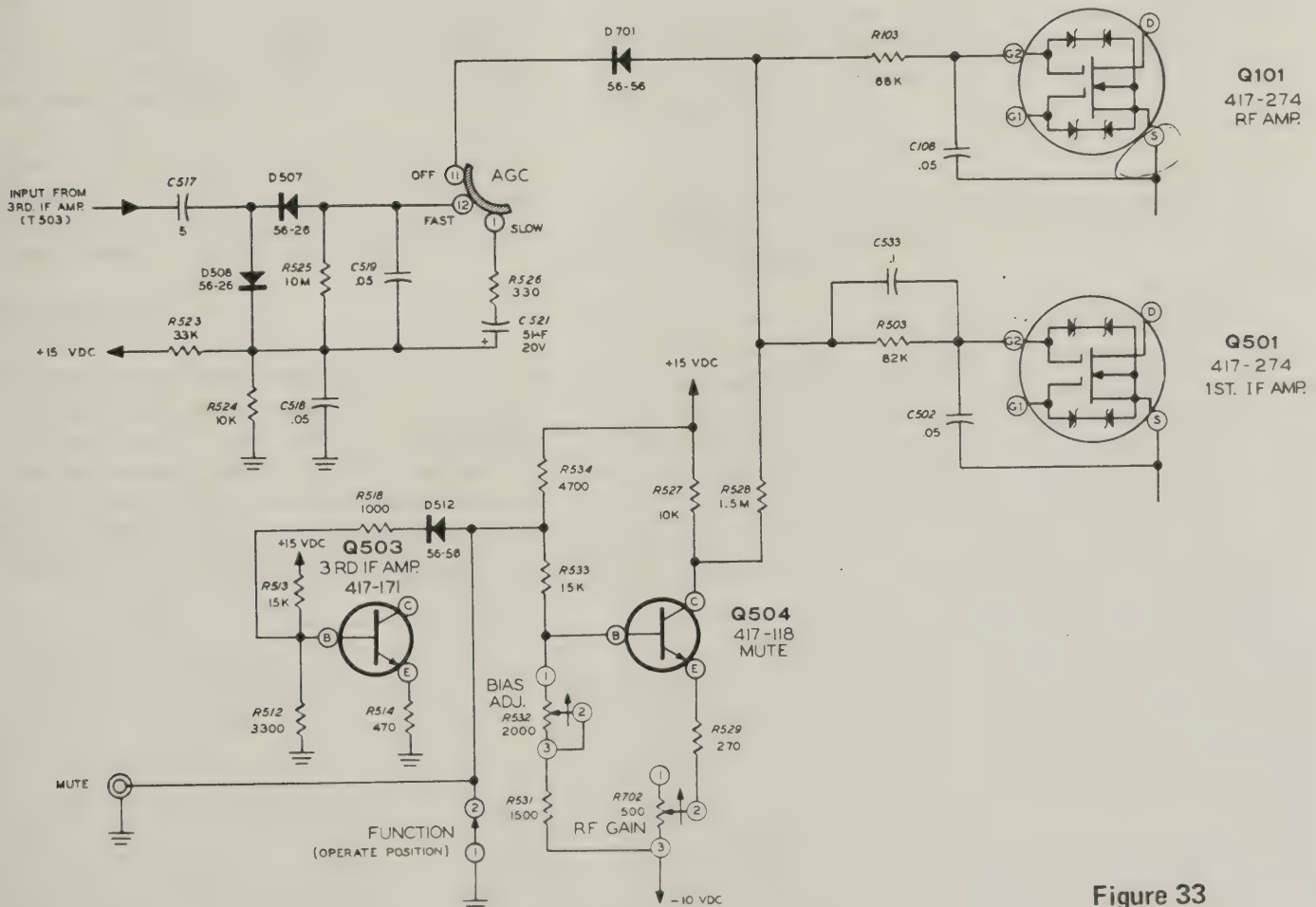


Figure 33

gate #2 of RF amplifier transistor Q101 and to gate #2 of first IF amplifier, transistor Q501. Excellent AGC action is obtained due to the wide AGC range of the dual gate MOS FET transistors.

For SSB operation it is desirable to have an AGC with a fast attack and a slow decay time. This is accomplished by placing the AGC switch in the SLOW position, which connects capacitor C521 and resistor R526 to the AGC line. The time constant of the resistor-capacitor combination allows fast charging of the capacitor, which results in fast-attack AGC. However, as the received signal disappears, the capacitor discharges slowly, resulting in a slow AGC decay time.

MUTE CIRCUIT

Mute transistor Q504 normally operates with a no-AGC-signal collector voltage of about 3.5 volts which is coupled to the AGC line through resistor R528. When the mute line is opened, the base of transistor Q504 becomes more positive, which results in greater collector current and a greater voltage drop across resistor R527. The result is a negative voltage on the AGC line, which cuts off Q101 and Q501. Also, the mute line is now positive, which causes diode D512 to conduct and increase the base current of transistor Q503. This increase in base current saturates Q503 to the point where it has no gain.

When the mute line is grounded, the RF gain can be adjusted by RF Gain control R702 which varies the AGC voltage. Bias Adjust control R532 determines the no-AGC-signal voltage on the collector of transistor Q504.

S-METER CIRCUIT

The source current from FET Q101 in the RF circuit is coupled through resistor R104 to the base of transistor Q505. In the same manner, the source current from FET Q501 is coupled through resistor R505 to the base of transistor Q506. The collectors of Q505 and Q506 are connected to the positive side of the S meter. When a strong signal is received, the source currents of Q101 and Q505 are

decreased due to AGC voltage. This negative-going voltage at the bases of transistors Q505 and Q506 causes their collector voltage to increase. The increased collector voltage is reflected across the S meter, providing an S-meter reading proportional to the received signal strength.

Diode D509 effectively connects the upper portion of control R542 across the meter at readings above half scale. This provides a linear dB deflection at the upper half of the meter scale.

HFO AND HFO AMPLIFIER

The HFO (Heterodyne Frequency Oscillator) operates as a tuned-collector, tuned-base oscillator. The base tuned circuit is a crystal which insures accurate and stable output frequency. The crystal is selected by band switch wafer BS-5F and coupled through capacitor C123 to the base of HFO transistor Q102. The collector tuned circuit is connected to the collector of Q102 through band switch wafer BS-4F. A detector circuit consisting of capacitors C124, C125, resistor R114 and diode D101 is provided for HFO alignment.

Power is supplied to the collector of transistor Q102 through resistor R109 and through the collector tuned coil, which in this case is L114. Resistors R111, R112, and R113 bias transistor Q102.

The oscillator signal is coupled from the collector of transistor Q102, through capacitor C126, to the first mixer and the HFO amplifier.

The signal is coupled through parasitic choke PC201 to the base of transistor Q201. The signal is coupled through emitter follower transistors Q201 and Q202 to the HFO OUT phono socket on the Receiver rear panel. The emitter followers present a high input impedance to the high frequency oscillator and a low output impedance to the HFO OUT phono socket. The HFO output voltage is used for transceive operation with a Heath Model SB-400 or SB-401 Transmitter.

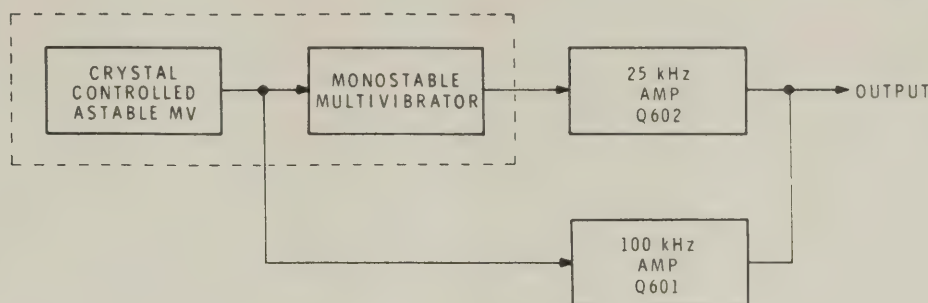


Figure 34

CRYSTAL CALIBRATOR

A block diagram of the crystal calibrator is shown in Figure 34. The dotted line on the block diagram indicates circuitry in integrated circuit IC601. Figure 35 is a simplified schematic of the crystal calibrator circuitry including components inside the integrated circuit.

When the Function switch is placed in the 100 kHz position, +15 volts is coupled through switch contacts 8 and 9 to the calibrator circuit. Transistors Q2 and Q3 are connected as an astable multivibrator. This circuit oscillates at a frequency determined by crystal Y601, and it can be adjusted slightly by trimmer capacitor C606.

The base of transistors Q1, Q4, and Q5 are not connected to the circuit, so these transistors have no effect in the circuit. Transistors Q6 and Q7 are connected as a monostable multivibrator which divides the 100 kHz output of Q3 to produce a 25 kHz output. The time constant of the multivibrator is determined by resistor R609 and capacitor C611.

Initially transistor Q7 is conducting and transistor Q6 is cut off. This places the collector of Q6 and the anode of diode D601 at 3.5 volts. When transistor Q3 of the multivibrator conducts, the cathode voltage of D601 drops and the diode conducts. This lowers the collector voltage on transistor Q6 and triggers the multivibrator. Diode D601 is now reverse biased until the multivibrator returns to its initial state.

When the Function switch is not in the 25 kHz position, transistor Q8 conducts because of the base current through

resistor R611. This clamps the collectors of Q7 and Q8 to ground and prevents the multivibrator from operating.

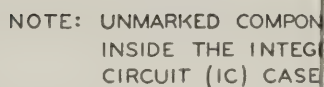
When the Function switch is in the 25 kHz position, the base of transistor Q8 is grounded, which brings it out of saturation. This permits normal operation of the multivibrator. The outputs of the astable and monostable multivibrators are amplified and added together in transistors Q601 and Q602. Figure 36 illustrates waveforms at four different points in the calibrator circuit when the Function switch is in the 25 kHz position.

BFO AND BFO AMPLIFIER

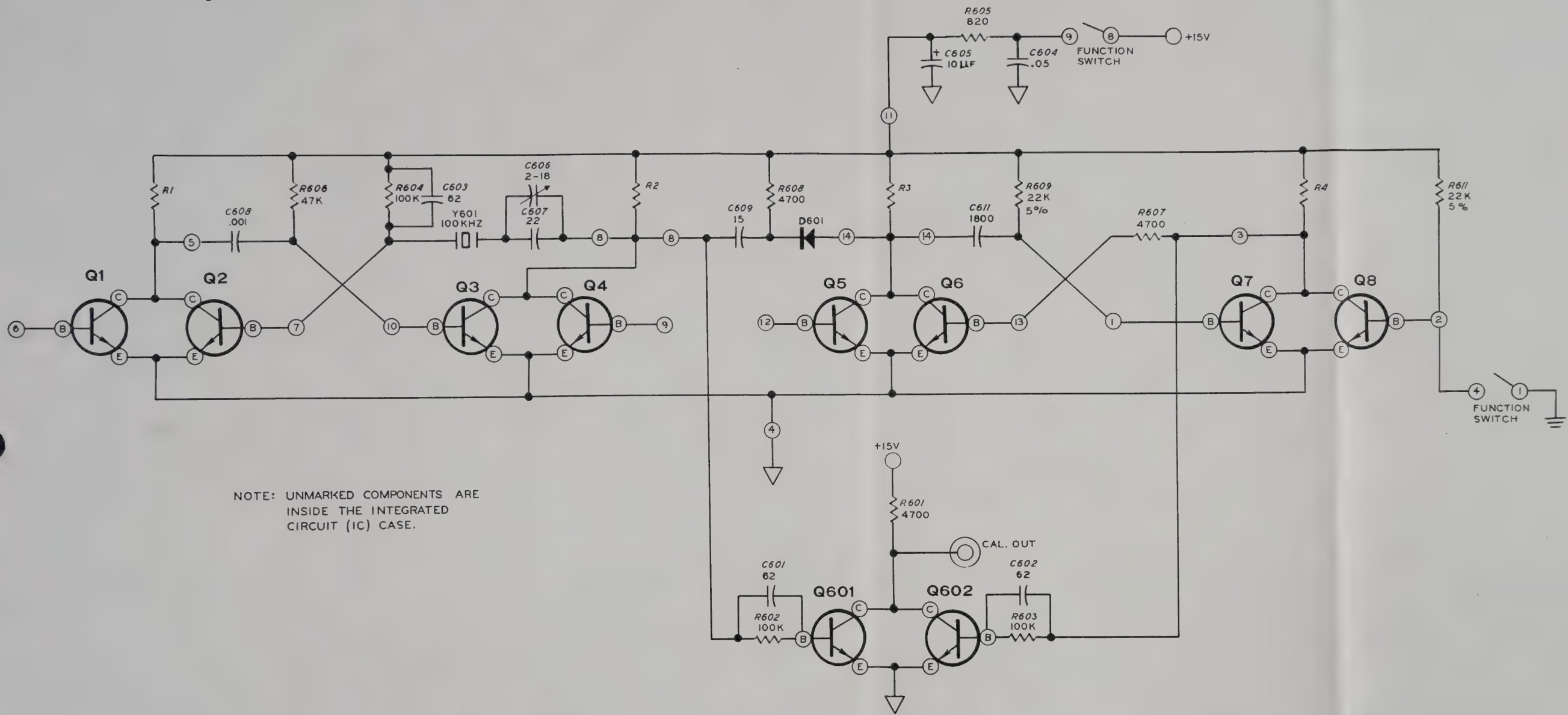
The BFO (beat frequency oscillator) is a crystal controlled oscillator composed of transistor Q605 and its associated circuitry. Crystals Y602, Y603, and Y604 are selected by mode switch wafer MS-5F to provide different frequencies.

The BFO signal from BFO transistor Q605 is coupled through resistor R629 to the base of transistor Q606. The signal from the emitter of Q606 is coupled through resistor R631 and capacitor C625 to the BFO to Detector jack. From here the signal will be coupled to the product detector.

The BFO signal is also coupled through capacitor C626 to transistor Q607 where the signal is amplified. The amplified signal from the collector of Q607 is coupled through capacitor C628 to the BFO Out jack. Coil L601 and capacitor C627 provide tuning for the BFO signal.



When the Function transistor Q8 conduc



NOTE: UNMARKED COMPONENTS ARE
INSIDE THE INTEGRATED
CIRCUIT (IC) CASE.

CALIBRATOR SCHEMATIC

FIGURE 35

CRYSTAL CALIB

A block diagram of t
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The base of transistor
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Transistors Q6 and
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produce a 25 kHz
multivibrator is deter
C611.

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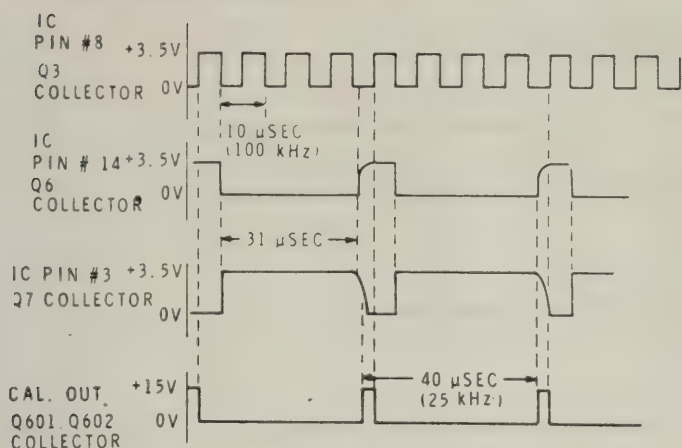


Figure 36

When the Mode switch is in the AM position, the collector of Q605 is grounded through Mode switch MS-5E. When the Mode switch is in the RTTY position, the output of Q607 is grounded through capacitor C629 and switch wafer MS-5F.

POWER SUPPLY

AC power is supplied through the circuit breaker and switch S701 to the primary of transformer T701. Transformer T701 has dual primary windings to permit operation from either 120 or 240 volts ac. The ac current from the secondary of transformer T701 is coupled to the full-wave rectifier.

Diodes D604 and D605 form the negative rectifier. From here negative dc power is supplied through resistors R612 and R613 to the Receiver. The negative dc supply is filtered by capacitors C616 and C617 and regulated by zener diode ZD601.

Diodes D602 and D603 form the positive voltage rectifier. From here positive dc is coupled through resistor R614 and the 1/2-ampere fuse to transistor Q603. The output power from Q603 is coupled through resistor R616 and control R617 to the base of transistor Q604. When the output power attempts to rise, the base voltage of Q604 increases. This causes Q604 to conduct heavier and decrease the current at the base of transistor Q603. This decrease in base current causes Q603 to appear as a high resistance in series with the output power. The reverse action takes place if the output voltage attempts to decrease.

RTTY CIRCUIT

When transceiving in the RTTY (radio teletype) mode, the LMO (linear master oscillator) frequency is shifted by changing the bias on a variable capacitance diode inside the LMO. The amount of shift is controlled by the RTTY shift circuit. When the transmitter is not keyed, the "wide" and "narrow" control lines are grounded. When the "wide" shift line is open, transistor Q303 conducts and causes the voltage at the FSK (frequency shift keying) terminal on the LMO to decrease. The amount of this decrease is adjusted by control R317.

The value of capacitor C302 is chosen to provide rise and fall times in the FSK voltages as shown in Figure 37.

The narrow switch transistor Q302, operates in a manner similar to Q303. CW switch Q301 is normally off, and the CW line is normally open. When an external key closes the CW line to ground, a narrow shift occurs. The amount of shift is controlled by control R308. Zener diode ZD301 regulates the voltage supplied to transistors Q301, Q302, and Q303.

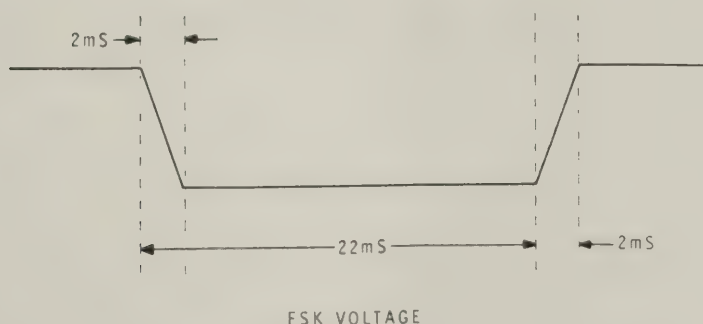
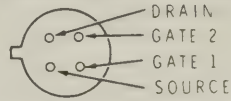
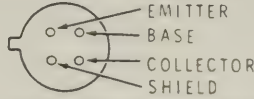
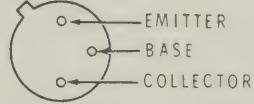
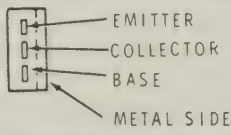
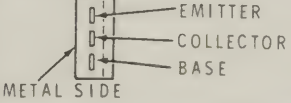
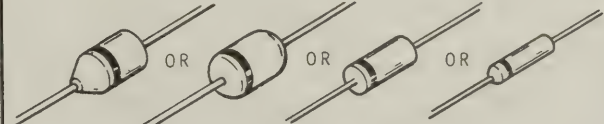
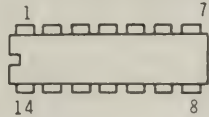


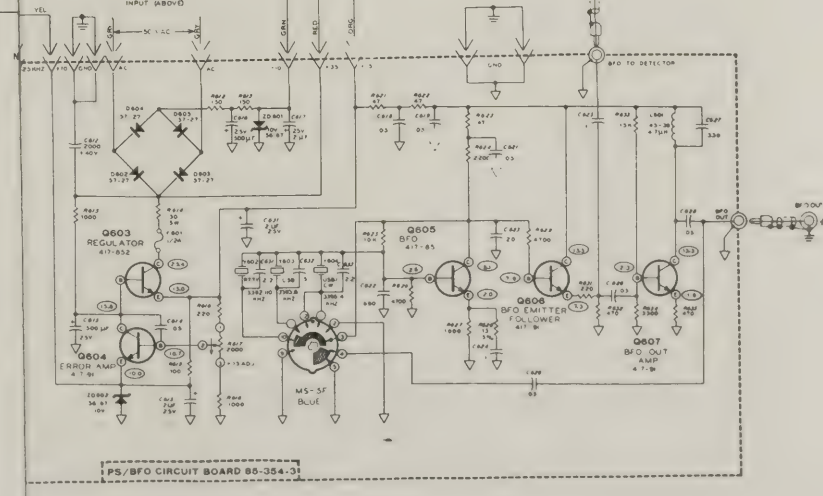
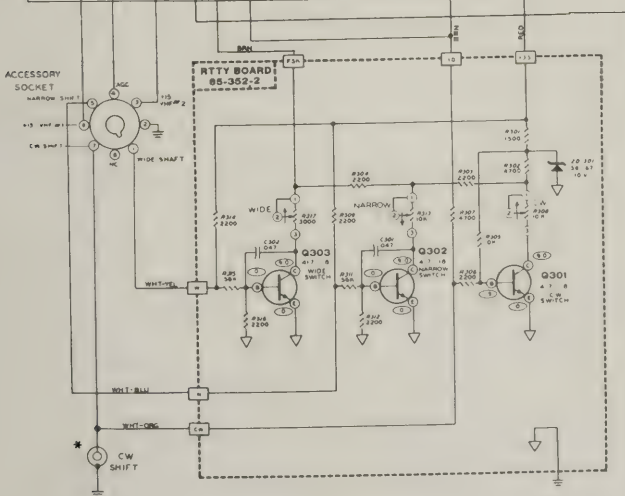
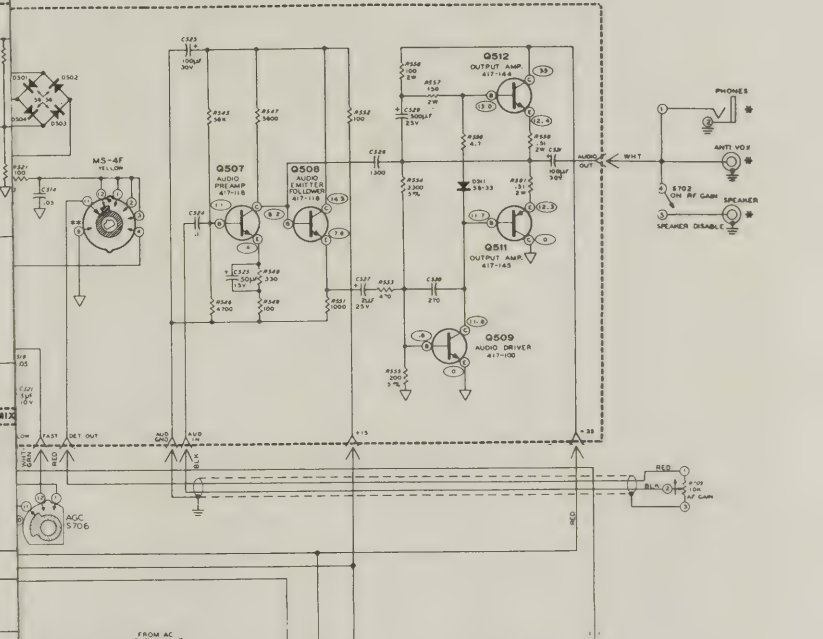
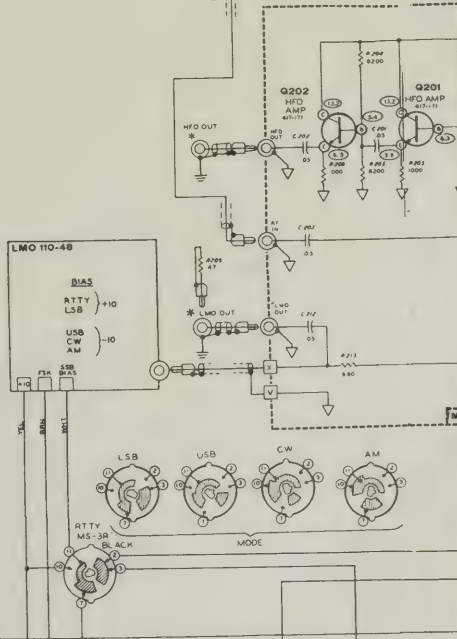
Figure 37

BASING DIAGRAMS

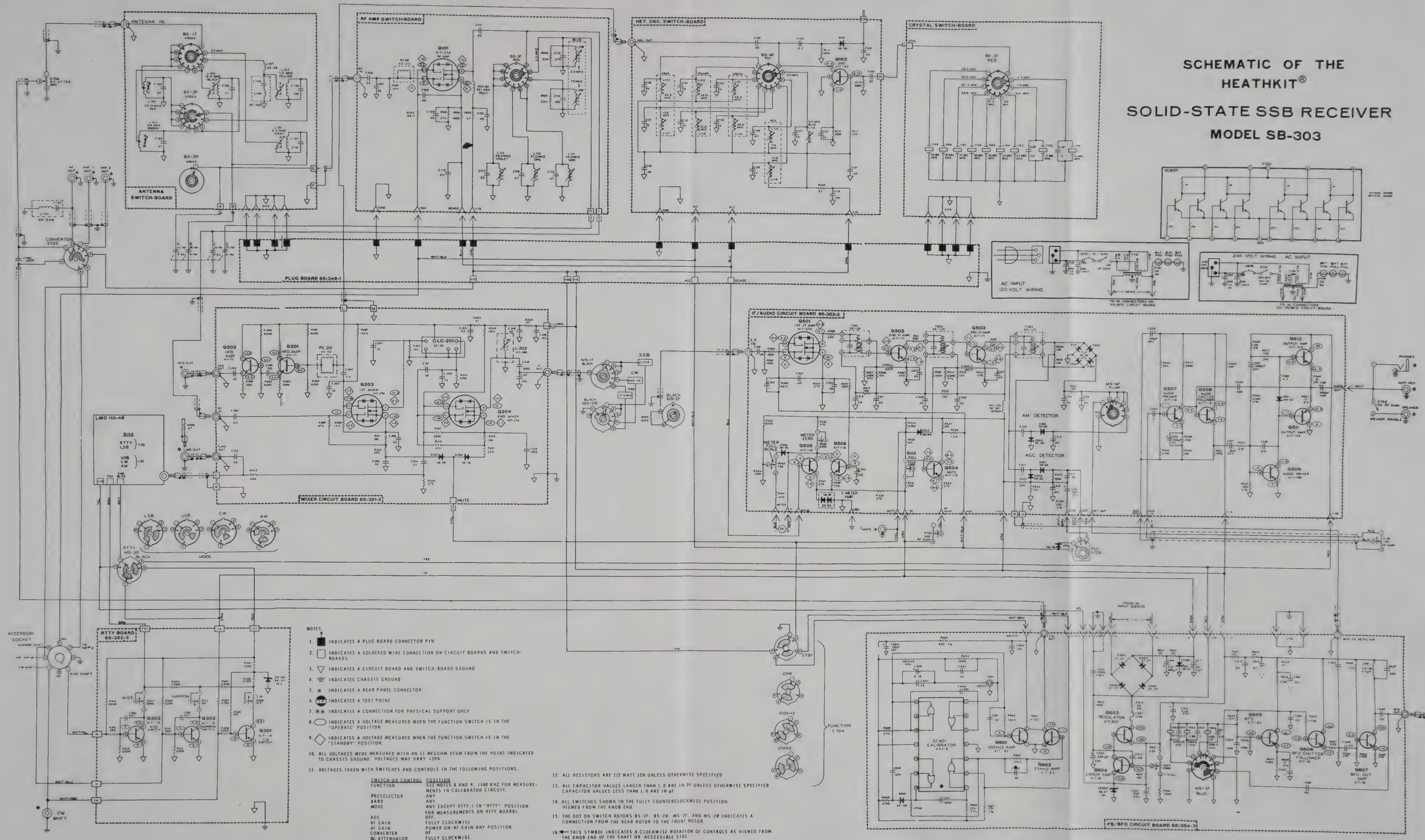
COMPONENT	HEATH PART NUMBER	MAY BE REPLACED WITH	BASE DIAGRAM (BOTTOM VIEW)
Q101, Q203, Q204, Q501	417-274	RCA 40673	
Q102	417-133	RCA 40245	
Q201, Q202, Q502, Q503	417-171	FAIRCHILD 2N3694	
Q301, Q302, Q303, Q504, Q505, Q506, Q507, Q508	417-118	G.E. OR T.I. 2N3393	
Q604 Q606 Q607	417-91	G.E. OR T.I. 2N5232A	
Q601, Q602, Q605	417-85	G.E. E844	
Q509	417-100	RCA 2N3053	
Q603	417-852	T.I. TIP31B	
Q511	417-145	MOT. MJE-371	
MOTOROLA MATCHED PAIR Q512	417-144	MOT. MJE-512	

COMPONENT	HEATH PART NUMBER	MAY BE REPLACED WITH	BASE DIAGRAM (BOTTOM VIEW)
D101, D201 D202, D501 D502, D503 D504, D509 D512, D601 D701	56-56	1N4149	NOTE: HEATH PART NUMBERS ARE STAMPED ON MOST DIODES. 
D505, D506 D507, D508	56-26-1	1N191	
D511	56-33	1N3754	
D602, D603, D604, D605	57-27	1N2071	
D513	56-61	G.E. STB-620	
ZD601, ZD602, ZD301	56-67	VR-10A	
IC601	443-8	MOT. MC724P	

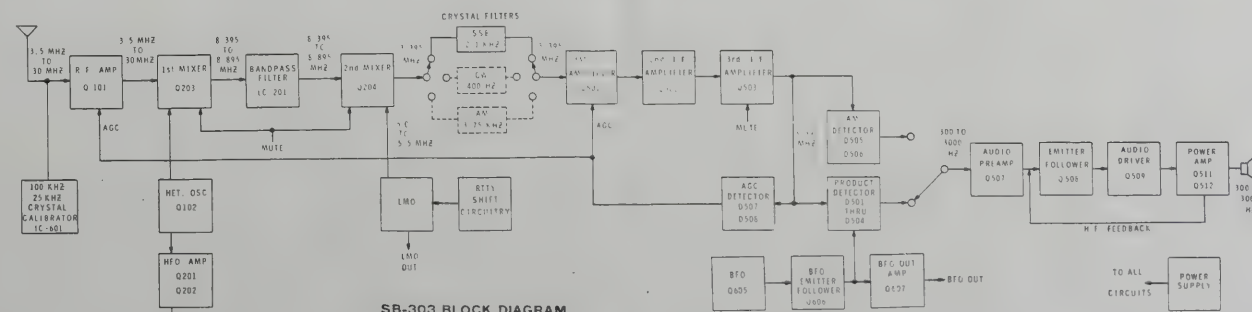
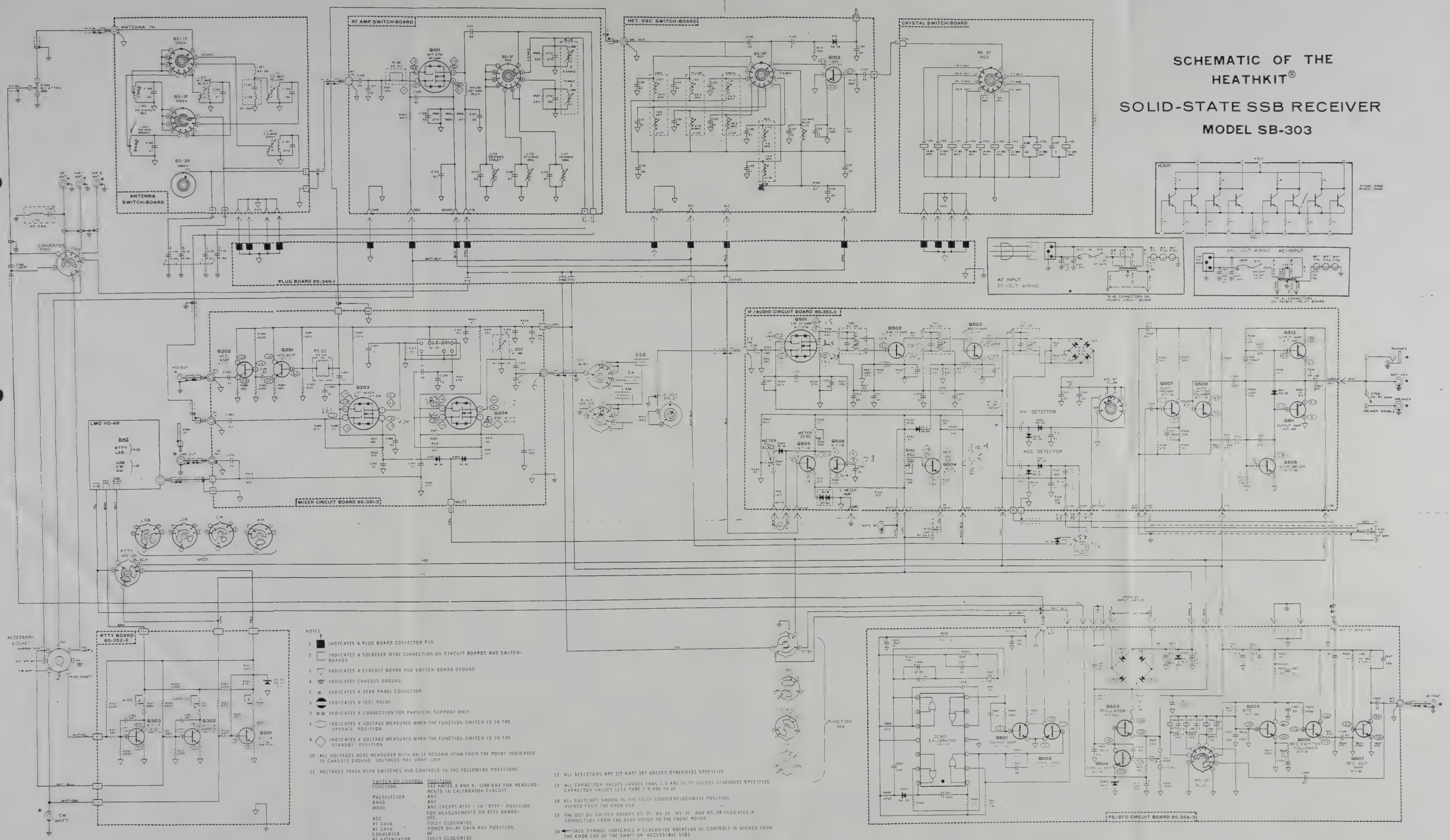
The schematic diagram illustrates a 100-watt VHF transmitter. The input stage features an antenna connected to a 704 RF attenuator, which is then connected to a 25F green BS-1F coupler. This coupler is part of a matching network consisting of a 25F green BS-2F coupler, a 25R BS-2R coupler, and a 100-watt converter. The converter is connected to a 100-watt plug board, which is in turn connected to a 100-watt antenna switch. The circuit includes various capacitors (C100, C101, C102, C103, C104, C105, C106, C107, C108, C109, C110, C111, C112, C113, C114, C115, C116, C117, C118, C119, C120, C121, C122, C123, C124, C125, C126, C127, C128, C129, C130, C131, C132, C133, C134, C135, C136, C137, C138, C139, C140, C141, C142, C143, C144, C145, C146, C147, C148, C149, C150, C151, C152, C153, C154, C155, C156, C157, C158, C159, C160, C161, C162, C163, C164, C165, C166, C167, C168, C169, C170, C171, C172, C173, C174, C175, C176, C177, C178, C179, C180, C181, C182, C183, C184, C185, C186, C187, C188, C189, C190, C191, C192, C193, C194, C195, C196, C197, C198, C199, C200, C201, C202, C203, C204, C205, C206, C207, C208, C209, C210, C211, C212, C213, C214, C215, C216, C217, C218, C219, C220, C221, C222, C223, C224, C225, C226, C227, C228, C229, C230, C231, C232, C233, C234, C235, C236, C237, C238, C239, C240, C241, C242, C243, C244, C245, C246, C247, C248, C249, C250, C251, C252, C253, C254, C255, C256, C257, C258, C259, C260, C261, C262, C263, C264, C265, C266, C267, C268, C269, C270, C271, C272, C273, C274, C275, C276, C277, C278, C279, C280, C281, C282, C283, C284, C285, C286, C287, C288, C289, C290, C291, C292, C293, C294, C295, C296, C297, C298, C299, C300, C301, C302, C303, C304, C305, C306, C307, C308, C309, C310, C311, C312, C313, C314, C315, C316, C317, C318, C319, C320, C321, C322, C323, C324, C325, C326, C327, C328, C329, C330, C331, C332, C333, C334, C335, C336, C337, C338, C339, C340, C341, C342, C343, C344, C345, C346, C347, C348, C349, C350, C351, C352, C353, C354, C355, C356, C357, C358, C359, C360, C361, C362, C363, C364, C365, C366, C367, C368, C369, C370, C371, C372, C373, C374, C375, C376, C377, C378, C379, C380, C381, C382, C383, C384, C385, C386, C387, C388, C389, C390, C391, C392, C393, C394, C395, C396, C397, C398, C399, C400, C401, C402, C403, C404, C405, C406, C407, C408, C409, C410, C411, C412, C413, C414, C415, C416, C417, C418, C419, C420, C421, C422, C423, C424, C425, C426, C427, C428, C429, C430, C431, C432, C433, C434, C435, C436, C437, C438, C439, C440, C441, C442, C443, C444, C445, C446, C447, C448, C449, C450, C451, C452, C453, C454, C455, C456, C457, C458, C459, C460, C461, C462, C463, C464, C465, C466, C467, C468, C469, C470, C471, C472, C473, C474, C475, C476, C477, C478, C479, C480, C481, C482, C483, C484, C485, C486, C487, C488, C489, C490, C491, C492, C493, C494, C495, C496, C497, C498, C499, C500, C501, C502, C503, C504, C505, C506, C507, C508, C509, C510, C511, C512, C513, C514, C515, C516, C517, C518, C519, C520, C521, C522, C523, C524, C525, C526, C527, C528, C529, C530, C531, C532, C533, C534, C535, C536, C537, C538, C539, C540, C541, C542, C543, C544, C545, C546, C547, C548, C549, C550, C551, C552, C553, C554, C555, C556, C557, C558, C559, C560, C561, C562, C563, C564, C565, C566, C567, C568, C569, C570, C571, C572, C573, C574, C575, C576, C577, C578, C579, C580, C581, C582, C583, C584, C585, C586, C587, C588, C589, C590, C591, C592, C593, C594, C595, C596, C597, C598, C599, C600, C601, C602, C603, C604, C605, C606, C607, C608, C609, C610, C611, C612, C613, C614, C615, C616, C617, C618, C619, C620, C621, C622, C623, C624, C625, C626, C627, C628, C629, C630, C631, C632, C633, C634, C635, C636, C637, C638, C639, C640, C641, C642, C643, C644, C645, C646, C647, C648, C649, C650, C651, C652, C653, C654, C655, C656, C657, C658, C659, C660, C661, C662, C663, C664, C665, C666, C667, C668, C669, C670, C671, C672, C673, C674, C675, C676, C677, C678, C679, C680, C681, C682, C683, C684, C685, C686, C687, C688, C689, C690, C691, C692, C693, C694, C695, C696, C697, C698, C699, C700, C701, C702, C703, C704, C705, C706, C707, C708, C709, C710, C711, C712, C713, C714, C715, C716, C717, C718, C719, C720, C721, C722, C723, C724, C725, C726, C727, C728, C729, C730, C731, C732, C733, C734, C735, C736, C737, C738, C739, C740, C741, C742, C743, C744, C745, C746, C747, C748, C749, C750, C751, C752, C753, C754, C755, C756, C757, C758, C759, C760, C761, C762, C763, C764, C765, C766, C767, C768, C769, C770, C771, C772, C773, C774, C775, C776, C777, C778, C779, C780, C781, C782, C783, C784, C785, C786, C787, C788, C789, C790, C791, C792, C793, C794, C795, C796, C797, C798, C799, C800, C801, C802, C803, C804, C805, C806, C807, C808, C809, C810, C811, C812, C813, C814, C815, C816, C817, C818, C819, C820, C821, C822, C823, C824, C825, C826, C827, C828, C829, C830, C831, C832, C833, C834, C835, C836, C837, C838, C839, C840, C841, C842, C843, C844, C845, C846, C847, C848, C849, C850, C851, C852, C853, C854, C855, C856, C857, C858, C859, C860, C861, C862, C863, C864



SCHEMATIC OF THE HEATHKIT® SOLID-STATE SSB RECEIVER MODEL SB-303



SCHEMATIC OF THE HEATHKIT® SOLID-STATE SSB RECEIVER MODEL SB-303



SB-303 BLOCK DIAGRAM

REPLACEMENT PARTS PRICE LIST

To order parts, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual.

ANTENNA, RF AMPLIFIER, HETERODYNE OSCILLATOR, AND CRYSTAL SWITCH-BOARDS

PART No.	PRICE Each	DESCRIPTION
-------------	---------------	-------------

RESISTORS

1-1	.15	47 Ω
1-42	.15	270 Ω
1-9	.15	1000 Ω
1-18	.15	5600 Ω
1-20	.15	10 k Ω
1-21	.15	15 k Ω
1-22	.15	22 k Ω
1-60	.15	68 k Ω
1-26	.15	100 k Ω

CAPACITORS

Mica

20-99	.25	22 pF
20-77	.25	24 pF
20-100	.25	30 pF
20-160	.25	33 pF
20-101	.25	47 pF
20-110	.25	75 pF
20-102	.25	100 pF
20-114	.30	270 pF

PART No.	PRICE Each	DESCRIPTION
-------------	---------------	-------------

Ceramic

21-33	.15	3.3 pF
21-78	.15	5 pF
21-143	.30	.05 μ F

Phenolic

28-1	.15	2.2 pF (red-red-white)
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RF CHOKES-DIODE-TRANSISTORS

45-38	1.00	Choke
45-43	1.00	Choke
56-56	.30	1N4149 diode
417-133	1.95	40245 transistor
417-274	2.30	40673 transistor

COILS

40-484	1.00	36 μ H fixed inductor (orange-blue)
40-546	1.00	Tuned trap
40-969	1.35	Antenna (gray dot)
40-970	1.75	Antenna (yellow dot)
40-971	1.35	Antenna (black dot)
40-972	1.35	Antenna (brown dot)
40-973	1.35	Antenna (red dot)

<u>PART No.</u>	<u>PRICE Each</u>	<u>DESCRIPTION</u>
Coils (cont'd.)		
40-975	1.30	RF (green dot)
40-976	1.30	RF (orange dot)
40-977	1.30	RF (violet dot)
40-978	1.30	Oscillator (blue dot)
40-974	1.80	RF (blue dot)
40-979	1.80	Oscillator (red dot)
40-980	1.80	Oscillator (gray dot)
40-981	1.80	Oscillator (yellow dot)
40-982	1.80	Oscillator (green dot)

CRYSTALS

404-207	5.40	12.395 MHz
404-208	5.40	15.895 MHz
404-209	5.85	22.895 MHz
404-210	5.85	29.895 MHz
404-211	5.85	36.895 MHz
404-212	5.85	37.395 MHz
404-213	5.85	37.895 MHz
404-214	5.85	38.395 MHz
404-279	5.45	23.895 MHz

<u>PART No.</u>	<u>PRICE Each</u>	<u>DESCRIPTION</u>
CONNECTORS		
432-77	.15	Switch-board connector
432-120	.15	Pin socket
432-121	.15	Connector pin
434-186	.15	Board phono socket
438-4	.15	Phono plug

MISCELLANEOUS

63-565	.95	Switch wafer
63-568	4.30	Switch wafer
340-8	.05/ft	Bare wire
344-16	.05/ft	Large red wire
344-56	.05/ft	Blue wire
343-12	.10/ft	Small coaxial cable
331-6	.25	Solder

ITEMS FROM PACK #6

85-345-1	2.15	Antenna Switch-board
85-346-1	1.85	RF amplifier Switch-board
85-347-1	1.85	Heterodyne oscillator Switch-board
85-348-1	2.15	Crystal Switch-board
	2.00	Manual (See front cover for part number.)

MIXER AND RTTY CIRCUIT BOARDS

PART No.	PRICE Each	DESCRIPTION
-------------	---------------	-------------

RESISTORS

1-1	.15	47 Ω
1-3	.15	100 Ω
1-45	.15	220 Ω
1-42	.15	270 Ω
1-7	.15	680 Ω
1-9	.15	1000 Ω
1-11	.15	1500 Ω
1-44	.15	2200 Ω
1-16	.15	4700 Ω
1-73	.15	8200 Ω
1-20	.15	10 k Ω
1-21	.15	15 k Ω
1-25	.15	47 k Ω
1-47	.15	56 k Ω
1-27	.15	150 k Ω

CAPACITORS

Mica		
20-52	.55	7.5 pF
20-160	.25	33 pF
20-113	.45	470 pF
20-122	.45	1000 μ F

Ceramic		
21-3	.15	10 pF
21-46	.15	.005 μ F
21-143	.30	.05 μ F

PART No.	PRICE Each	DESCRIPTION
-------------	---------------	-------------

Mylar		
27-73	.25	.047 μ F

DIODES

56-56	.30	1N4149 diode
56-67	1.65	Zener diode

TRANSISTORS

417-118	.40	2N3393
417-171	.75	2N3694
417-274	2.30	40673

MISCELLANEOUS

10-242	1.00	3000 Ω linear control (3 k Ω)
10-201	1.00	10 k Ω linear control
40-666	1.20	Coil
45-43	1.00	RF choke
52-126	24.00	LC filter
205-87	.40	RF shield
206-244	.60	Coil shield
259-20	.05	Solder pin
432-121	.15	Connector pin
434-186	.15	Board phono socket
438-4	.15	Phono plug
344-15	.05/ft	Large black wire

ITEMS FROM PACK #6

85-351-2	1.80	Mixer circuit board
85-352-2	1.60	RTTY circuit board

IF/AUDIO CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION
-------------	---------------	-------------

RESISTORS

1/2-Watt

1-129	.15	4.7 Ω
1-3	.15	100 Ω
1-137	.15	200 Ω , 5%
1-42	.15	270 Ω
1-4	.15	330 Ω
1-6	.15	470 Ω
1-9	.15	1000 Ω
1-11	.15	1500 Ω
1-122	.15	3300 Ω , 5%
1-16	.15	4700 Ω
1-18	.15	5600 Ω
1-73	.15	8200 Ω
1-20	.15	10 k Ω
1-21	.15	15 k Ω
1-24	.15	33 k Ω
1-47	.15	56 k Ω
1-102	.15	82 k Ω
1-36	.15	1.5 M Ω
1-40	.15	10 M Ω

Other Resistors

3-6-2	.50	.51 Ω 5%, 2-watt
1-20-2	.20	100 Ω , 2-watt
1-42-2	.20	150 Ω , 2-watt

CONTROLS

10-294	1.00	2000 Ω (2 k Ω)
10-295	1.00	750 Ω

CAPACITORS

Ceramic

21-78	.15	5 pF
21-25	.15	1300 pF
21-143	.30	.05 μ F

Electrolytic

25-123	.60	2 μ F
25-125	.60	5 μ F
25-116	.75	50 μ F
25-146	.70	100 μ F
25-199	.90	500 μ F

Other Capacitors

20-114	.30	270 pF mica
27-47	.30	.1 μ F Mylar

PART No.	PRICE Each	DESCRIPTION
-------------	---------------	-------------

COIL-TRANSFORMERS-DIODES

40-581	1.00	620 μ H fixed inductor
52-125	1.45	3.395 MHz IF transformer
56-26-1	.45	1N191 diode
56-56	.30	1N4149 diode
56-33	.85	1N3754 diode
56-61	.95	Stabistor diode

TRANSISTORS

417-100	1.50	2N3053/36632
417-118	.40	2N3393
417-171	.75	2N3694
417-274	2.30	40673
117-9	5.00	Transistor package

Consisting of:

417-144		MJE521
417-145		MJE371
254-22		Torque washer

HEAT SINKS-HARDWARE

215-19	.15	Clamp heat sink
215-31	.45	TO-5 heat sink
215-39	1.00	Audio heat sink
250-273	.05	4-40 x 3/8" screw
250-285	.05	4-40 x 1/4" screw
252-15	.05	4-40 nut
254-9	.05	#4 lockwasher

MISCELLANEOUS

63-566	.90	Switch wafer (yellow dot)
75-704	.15	Insulator
352-13	.25	Silicone grease
432-124	.15	Circuit board connector
434-186	.15	Board phono socket
438-4	.15	Phono plug
490-5	.15	Nut starter

ITEMS FROM PACK #6

204-1046	.90	Support rail
85-353-7	5.00	IF/audio circuit board

POWER SUPPLY/BFO CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION
-------------	---------------	-------------

RESISTORS

1/2-Watt

1-54	.15	15 Ω , 5%
1-1	.15	47 Ω
1-3	.15	100 Ω
1-66	.15	150 Ω
1-45	.15	220 Ω
1-6	.15	470 Ω
1-79	.15	820 Ω , 5%
1-9	.15	1000 Ω
1-44	.15	2200 Ω
1-14	.15	3300 Ω
1-16	.15	4700 Ω
1-20	.15	10 k Ω
1-21	.15	15 k Ω
1-58	.15	22 k Ω , 5%
1-25	.15	47 k Ω
1-26	.15	100 k Ω

Other Resistors

3-17-5	.50	50 Ω , 5-watt resistor
10-294	1.00	2000 Ω linear control (2 k Ω)

CAPACITORS

Mica

20-118	.25	15 pF
20-99	.25	22 pF
20-109	.25	62 pF
20-139	.40	330 pF
20-107	.60	680 pF

Ceramic

21-157	.15	5 pF
21-51	.15	20 pF
21-163	.15	.001 μ F
21-143	.30	.05 μ F

Electrolytic

25-123	.60	2 μ F
25-54	.30	10 μ F
25-199	.90	500 μ F
25-192	2.00	2000 μ F

Other Capacitors

27-47	.30	.1 μ F Mylar
28-1	.15	2.2 pF phenolic (red-red-white)
31-57	1.05	2.7 - 20 pF ceramic trimmer
29-4	.15	1800 pF polystyrene

PART No.	PRICE Each	DESCRIPTION
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RF CHOKE-DIODES-INTEGRATED CIRCUIT

45-39	1.00	RF choke
56-56	.30	1N4149 diode
57-27	.75	1N2071 diode
56-67	1.65	Zener diode
443-8	1.80	MC724P integrated circuit

TRANSISTORS

417-91	.85	2N5232A
417-85	.70	E844
417-852	1.10	TIP31B

CRYSTALS

404-43	6.75	100 kHz
404-280	5.00	3392.110 kHz
404-205	5.00	3393.6 kHz
404-206	5.00	3396.4 kHz

HARDWARE

250-285	.05	4-40 x 1/4" screw
252-15	.05	4-40 nut
254-9	.05	#4 lockwasher
250-89	.05	6-32 x 3/8" screw
252-3	.05	6-32 nut
254-1	.05	#6 lockwasher
253-2	.05	#6 fiber shoulder washer

MISCELLANEOUS

63-567	1.05	Switch wafer
75-102	.15	Insulator
215-40	1.00	Heat sink
260-56	.15	Fuse clip
421-13	.25	1/2-ampere fuse
434-186	.15	Board phono socket
432-124	.15	Circuit board connector

ITEMS FROM PACK #6

204-1046	.90	Support rail
85-354-3	4.30	Power supply/BFO board

PLUG BOARD AND EXTENDER ACCESSORIES

PART No.	PRICE Each	DESCRIPTION	PART No.	PRICE Each	DESCRIPTION
432-98	.65	Switch-board plug	ITEMS FROM PACK #6		
432-77	.15	Switch-board connector	85-349-1	1.70	Plug board
432-124	.15	Circuit board connector	85-355	1.75	Small extender board
255-108	.20	Extender block	85-356	3.55	Large extender board
262-24	.20	Extender pin			
434-42	.15	Chassis phono socket			
438-4	.15	Phono plug			

CHASSIS

PART No.	PRICE Each	DESCRIPTION	PART No.	PRICE Each	DESCRIPTION
-------------	---------------	-------------	-------------	---------------	-------------

RESISTORS

1/2 Watt

1-1	.15	47 Ω
1-2	.15	68 Ω
1-42	.15	270 Ω
1-9	.15	1000 Ω

5 Watt

3-17-5	.50	50 Ω
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DIODE-CONTROLS

56-56	.30	1N4149 diode
10-34	1.40	600 Ω control
19-143	2.90	500 Ω control with SPST switch
19-95	1.60	10 k Ω AUD (audio) control with SPST switch

CAPACITORS-TRAP

28-3	.15	.56 pF phenolic capacitor
21-72	.20	.005 μ F ceramic capacitor (1.4 kV line bypass)
26-74	9.20	24-194 pF variable capacitor
40-546	1.00	Tuned trap

SWITCHES

63-563	2.15	4-position
63-564	2.50	3-position
63-569	4.05	5-position
63-572	1.60	3-position

CONNECTORS

432-27	.40	Line cord adapter
432-76	.90	AC power socket
432-120	.15	Pin socket
432-180	.45	Circuit board connector
434-2	.15	Accessory socket
434-42	.15	Chassis phono socket
434-88	.15	Lamp socket (short bracket)
434-90	.15	Lamp socket (long bracket)
436-20	.55	Phone jack
438-4	.15	Phono plug
438-25	.65	LMO load plug
438-6	.50	Accessory plug
440-1	.35	Accessory plug cap

PART No.	PRICE Each	DESCRIPTION
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GROMMETS-TERMINAL STRIPS

73-3	.15	1/2" grommet
73-2	.15	3/4" grommet
431-10	.15	3-lug terminal strip
431-11	.15	5-lug terminal strip

HARDWARE

#3 Hardware

250-251	.05	3-48 x 3/8" flat head screw
252-1	.05	3-48 nut
254-7	.05	#3 lockwasher

#4 Hardware

250-156	.05	4-40 x 1/8" setscrew
250-285	.05	4-40 x 1/4" screw
252-15	.05	4-40 nut
254-9	.05	#4 lockwasher

#6 Hardware

250-40	.05	6-32 x 1-1/2" screw
250-56	.05	6-32 x 1/4" screw
250-89	.05	6-32 x 3/8" screw
250-218	.05	6-32 x 3/8" phillips screw
250-364	.05	6-32 x 7/8" screw
250-327	.05	6-32 x 1/4" flat head screw
250-170	.05	#6 x 1/4" sheet metal screw
250-127	.05	6-32 x 1/2" self-tapping screw
252-3	.05	6-32 nut
252-85	.10	6-32 speednut
253-60	.05	#6 flat washer
254-1	.05	#6 lockwasher
255-23	.10	6-32 x 15/32" tapped spacer
259-1	.05	#6 large solder lug
259-6	.05	#6 small solder lug

#8 Hardware

250-137	.05	8-32 x 3/8" screw
250-87	.05	8-32 x 3/16" screw
250-93	.05	8-32 x 1/4" setscrew
254-2	.05	#8 lockwasher
252-4	.05	8-32 nut

Control Hardware

253-36	.05	Control spring washer
252-7	.05	Control nut
253-10	.05	Control flat washer
254-5	.05	Control lockwasher
259-10	.05	Control solder lug

PART No.	PRICE Each	DESCRIPTION
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SHEET METAL PARTS

90-415	20.45	Cabinet
200-556	9.00	Front chassis
200-557	3.00	Rear chassis
203-657-2	3.70	Front panel
203-656	2.40	Rear panel
100-927	3.55	Right side panel
203-735	2.10	Left side panel
100-928	2.70	Left subpanel
206-460	1.20	IF shield
206-461	.75	RF shield
205-1560	1.30	3-position connector plate
205-1561	1.30	2-position connector plate
100-929	.60	Rear panel bracket
100-930	2.55	RTTY bracket
206-504	.40	Switch bracket
204-557	.40	Capacitor bracket
204-363	.30	Angle bracket

DIAL PARTS

446-40	1.85	Escutcheon
204-553	1.05	Dial-mounting bracket
100-443	2.00	Dial pointer assembly
464-30-1	.70	Plastic dial window
100-447	.75	Dial pointer drive arm
250-63	.05	3-48 x 1/8" screw
266-74	.15	Nylon spiral follower
100-445	.30	Zero set drive pulley (small)
100-449	4.65	Circular dial
100-444	1.15	Dial drive pulley (large)
455-42	1.45	Drive shaft bushing assembly

MISCELLANEOUS MECHANICAL

206-86	.15	Pilot lamp shield
255-59	.15	Foot spacer
261-9	.05	Foot
266-159	.75	5-position switch detent
266-160	.75	9-position switch detent
391-65	.35	SB-303 nameplate
453-90	.15	1-7/8" shaft
453-193	.45	10-3/4" shaft

PART No.	PRICE Each	DESCRIPTION
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Miscellaneous Mechanical (cont'd.)

453-194	1.35	7-1/2" shaft
453-195	1.45	11-3/8" shaft
455-6	.15	Bushing
455-15	.15	Shaft collar
456-7	.40	Coupling
462-175	.30	Zero set knob
462-191	1.25	Small knob
462-193	3.65	Large knob

MISCELLANEOUS ELECTRICAL

110-48	94.00	LMO (linear master oscillator)*
54-242	8.60	Power transformer
404-283	44.30	SSB crystal filter
407-99	15.75	Meter
65-29	4.05	Circuit breaker
412-1	.25	#47 pilot lamp
413-39	**	Lamp lens

*If your old tuner is repairable, you can return it to the Heath Company for a credit or rebate against the cost of the replacement tuner (after you get the replacement tuner if you prefer). You can also return it to a Heathkit Electronic Center.

**Write to Heath Company for price information.

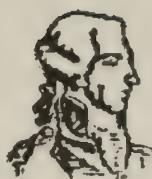
PART No.	PRICE Each	DESCRIPTION
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WIRE

89-51	3.75	Line cord
134-212	5.65	Wire harness
343-5	.20/ft	RG-62/U coaxial cable
343-12	.10/ft	RG-174/U coaxial cable
344-51	.05/ft	Brown wire
344-53	.05/ft	Orange wire
344-54	.05/ft	Yellow wire

TOOLS

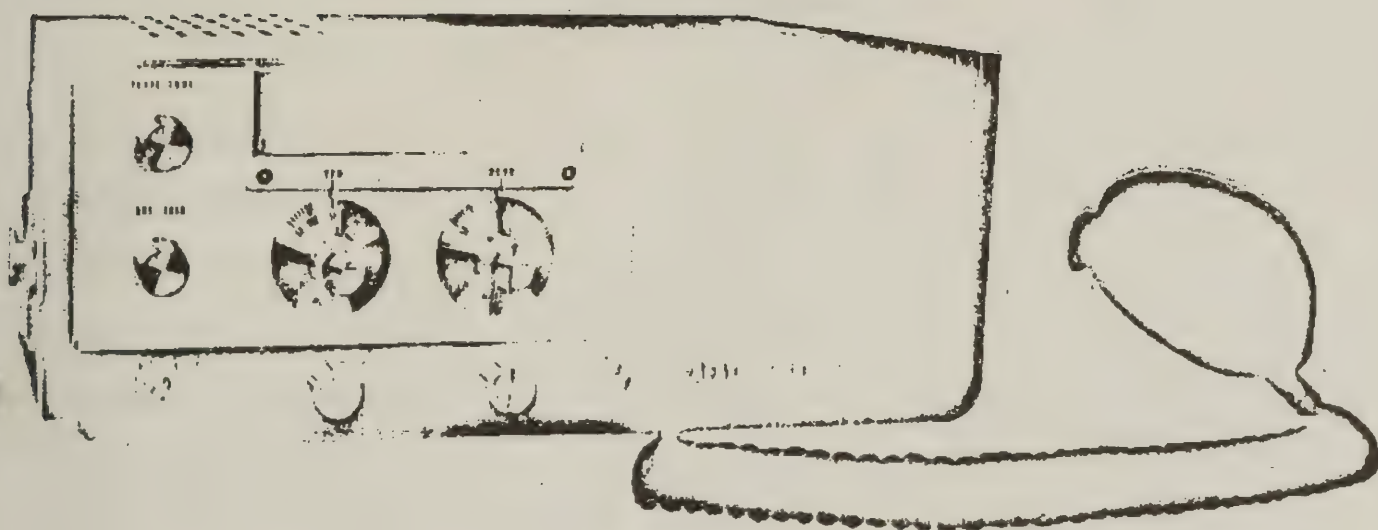
490-1	.15	Large alignment tool
490-109	.15	Small alignment tool
490-85	.20	Long allen wrench
490-23	.15	Small allen wrench
490-168	.25	1/4" open-end wrench



LAFAYETTE

Model HA-460

(Stock No. 99-2579WX)



6-METER AMATEUR TRANSCEIVER

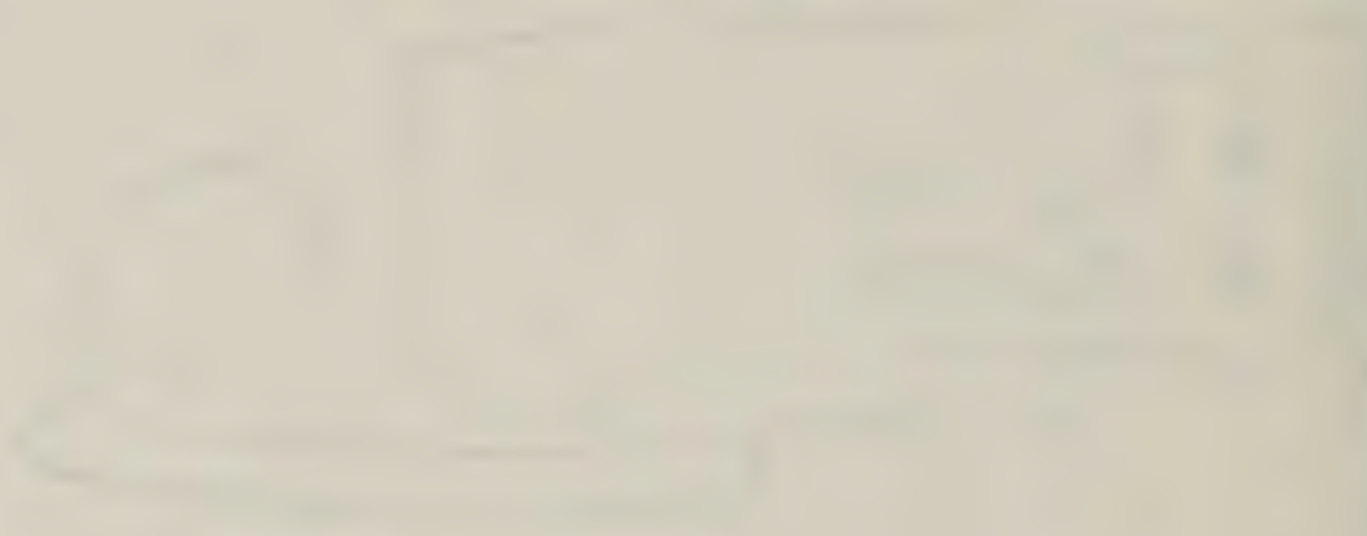
*INSTALLATION and
OPERATING MANUAL*



LAFAYETTE RADIO ELECTRONICS CORPORATION

CHINESE HISTORY

Introduction



CHINESE HISTORY
Introduction

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SPECIFICATIONS

RECEIVER

SENSITIVITY	Less than 1uv. for 10 db $\frac{s + n}{n}$
SELECTIVITY	± 3 Kc at 6 db down, less than ± 12 Kc at 50 db down
INPUT IMPEDANCE	50 ohms (unbalanced)
OUTPUT IMPEDANCE	8 ohms
TUNING RANGE	50.0 Mc to 52.0 Mc
IF FREQUENCIES	1st: 5745 Kc; 2nd: 455 Kc
AUDIO OUTPUT	4 watts

TRANSMITTER

POWER INPUT	20 watts
TUNING RANGE	50.0 Mc to 52.0 Mc
CRYSTAL FREQUENCIES	8.334 Mc to 8.666 Mc
MICROPHONE	High impedance ceramic with push-to-talk switch
OUTPUT IMPEDANCE	50 ohms (unbalanced)
TRANSMISSION MODE	Type A3 emission (AM)

GENERAL

AC POWER REQUIREMENTS	117 volts, 60 cps, 160 watts (maximum)
DC POWER REQUIREMENTS	12 volts DC at 14 amperes (maximum)
DIMENSIONS	12-1/8 W x 5-1/8 H x 9-1/4 D
WEIGHT	19 lbs

GENERAL DESCRIPTION

INTRODUCTION

The Lafayette Model HA-460 is a compact, self-contained 6-meter radio station. Its compact size, ease of mounting, and universal power supply make this unit ideally suitable for operation as a 12 volt DC mobile unit or fixed station operation from a 117 volt, 60 cycle AC power source. The HA-460 covers the most popular lower portion of the 6 meter band (50-52 Mc). It is supplied complete with a push-to-talk microphone, power cables for AC and DC operation, and a mobile mounting bracket.

NOTE

An FCC amateur license is required by anyone operating this equipment.

FEATURES

Built-in solid-state universal power supply. Operates from 117 volts AC or 12 volts DC.
Crystal-controlled or VFO transmitter operation.
Built-in TVI filter.
Spot switch.
S-meter/Relative power indicator.
6CW4 Low-Noise RF amplifier; Crystal-controlled dual conversion IF system.
Built-in speaker.

TUBE AND TRANSISTOR COMPLEMENT

V1	RF amplifier
V2	1st mixer and local oscillator 1
V3	2nd mixer and local oscillator 2
V4	1st IF amplifier and microphone amplifier
V5	2nd IF amplifier
V6	2nd preamplifier and audio power amplifier/modulator
V7	Phase inverter and audio power amplifier/modulator
V8	Frequency doubler driver and frequency doubler/tripler
V9	RF power amplifier
V10	VFO/Crystal oscillator and buffer amplifier
2SB425 (4)	D.C. power supply transistor

DIODE COMPLEMENT

1N60	Audio detector
1S72	noise limiter
1S93/10D6 (4)	Rectifier, PEAK CLIPPER
1S34	RF Meter rectifier
5F10	Power supply polarity reversal protection
5GF/10D4	S METER RECTIFIER

INSTALLATION

LOCATION

The HA-460 may be placed in any location that will permit free air circulation through the ventilation holes and openings in the cabinet.

In fixed-station use, avoid excessively warm locations such as those near radiators and heating vents. Also, avoid direct blasts of air from circulating fans, etc. Do not place any object on the cabinet cover that will impair natural ventilation.

In mobile installations, avoid direct air blasts from heaters or air conditioning units. See Figure 1 for mounting procedure.

CONNECTION TO POWER SOURCE

The HA-460 may be used for 117 volt, 60 cycle AC operation or 12 volt DC operation by selecting the correct power cord and plug assembly.

In fixed installations where a 117 volt AC source will be used, the power cord with the standard two-contact plug on one end is used.

In mobile installations the power lead with the in-line fuseholder is used. It is recommended that the bare end of this wire be connected directly to the battery terminal. Connection of this lead to other points may cause reduced voltage, increased ignition interference, etc. If additional length is required, wire no smaller than No. 14 AWG should be used.

The DC power cable must be connected in the following manner. The red (fused) lead should always be connected to the battery terminal which serves as the "hot" side of the system. This means that in a negative ground vehicle, the red fused lead must be connected to the positive battery terminal. In a positive ground vehicle, the red fused lead must be connected to the negative battery terminal. In each case the battery ground switch on the transceiver must be set for the type of ground employed in the vehicle.

NOTE: Make sure the BATTERY GROJND switch is set for the ground polarity of the vehicle in which the HA-460 is to be installed. The HA-460 will not operate unless this switch is in the proper position.

ANTENNAS

The HA-460 is designed for 50-ohm termination; therefore, any $\frac{1}{4}$ -meter antenna providing 50-ohm termination may be used. Antenna polarization is very important at these frequencies and should be considered when choosing an antenna. Generally speaking, the antenna polarization should be compatible with that of the stations you will normally be in contact with.

The antenna should be connected to the antenna receptacle on the back of the unit using RG-8/U is recommended for lengths in excess of 100 feet).

It is important that the antenna be adjusted for the lowest possible VSWR at your normal operating frequency. Additional information on antennas may be found in the ARRL Handbook or in the ARRL Antenna Manual.

HEADPHONES

The headphone jack, located lower right corner, is wired so that the internal speaker is automatically disabled when the headphone plug is inserted.

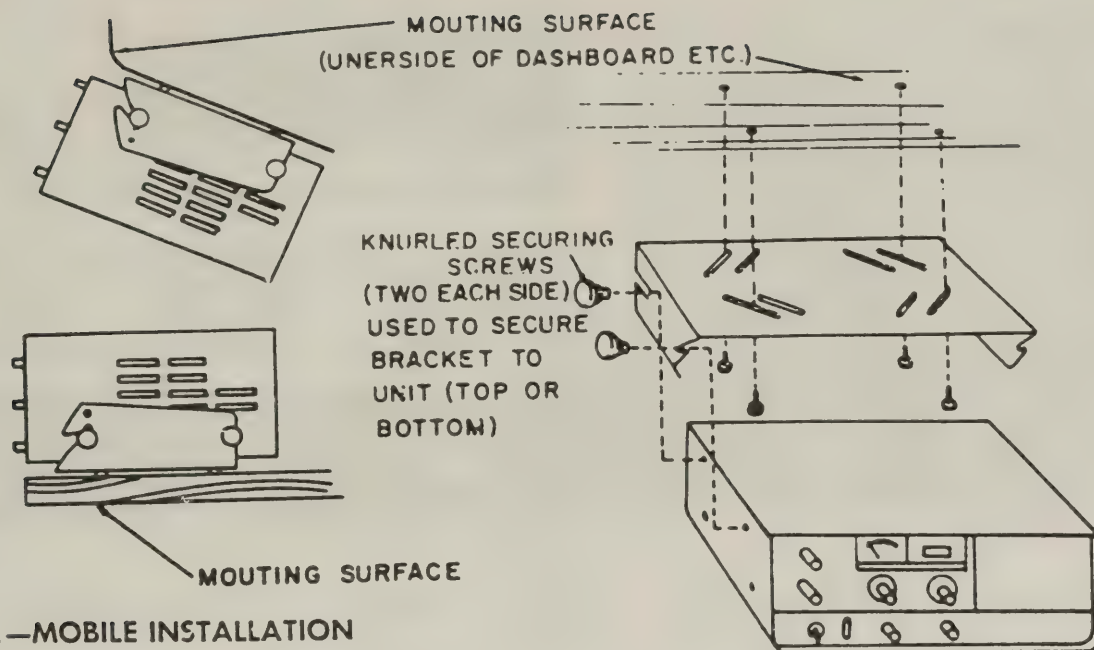


FIGURE 1—MOBILE INSTALLATION

OPERATION

CONTROLS, INDICATORS AND CONNECTORS

The controls, indicators and connectors necessary for the operation of the HA-460 are listed in Table 1.

TABLE 1 CONTROLS, INDICATORS AND CONNECTORS

Control, Indicator or Connector	Function
(1) PLATE TUNE Control	Tunes transmitter power amplifier plate circuit for maximum power output.
(2) S-METER/RELATIVE POWER METER	Receive Mode: Indicates strength of received signal on S-Meter calibrated in S-Units from 1 to 9 and from 10 to 30 db above S9. Transmit Mode: Indicates relative power output of transmitter.
(3) SPOT Switch	In the ON position: Applies plate voltage to the transmitter oscillator when in receive mode. This causes generation of a strong unmodulated signal which may be tuned in on the receiver to determine the frequency of transmission.
(4) PHONES Jack	Permits connection of headphones or external speaker (4 - 8 ohms). Insertion of plug into jack automatically silences internal speaker.

- | | |
|-----------------------------|---|
| (5) RCVR Tuning Control | Permits receiver tuning over the 50-52 Mc segment of the 6 meter band. |
| (6) MIC Jack | Permits connection of microphone. |
| (7) VOL Control | Adjusts the level of the audio output. |
| (8) VFO Tuning Control | Permits transmitter tuning over the 50-52 Mc segment of the 6 meter band when in VFO mode. |
| (9) XTAL-VFO Switch | Permits selection of either crystal or VFO operation of the transmitter oscillator. |
| (10) CRYSTAL Socket | Crystal is inserted in socket when transmitter is operated in XTAL mode. |
| (11) POWER Switch | Turns transceiver ON or OFF. |
| (12) ANT. LOAD Control | Tunes output portion of pi network for maximum power transfer into antenna load. |
| (13) BATTERY GROUND Switch | Selects positive or negative ground for mobile operation. |
| (14) BATTERY REVERSAL DIODE | Provides protection against incorrect DC power connection. |
| (15) METER ADJ Control | Provides an electrical zero adjustment for the S-Meter/Relative Power Meter. |
| (16) POWER Connector | This eleven pin connector accepts plug connectors (supplied) for direct connection to 115 volt, 60 cps power supply, or to 12 volt DC power supply. |
| (17) ANT. Connector | Provides connection for antenna transmission line. |

RECEIVER OPERATION

To operate the receiver portion of the HA-460 Transceiver, proceed as follows:

- (a) Connect a 6-meter 50-ohm antenna to the ANT receptacle located on the rear of the chassis.
- (b) Connect either the AC or DC power cord supplied with the unit to the eleven pin POWER connector located on the rear of the chassis, and an appropriate power source.
- (c) Set the POWER switch to ON. The dial window should become illuminated indicating power is applied to the transceiver.
- (d) Adjust the VOL control for the desired audio level.
- (e) Rotate the RCVR tuning control to the desired frequency.

NOTE: If desired, headphones may be used in place of the internal speaker. To use headphones, simply plug them into the PHONES jack on the front panel. This will automatically silence the internal speaker.

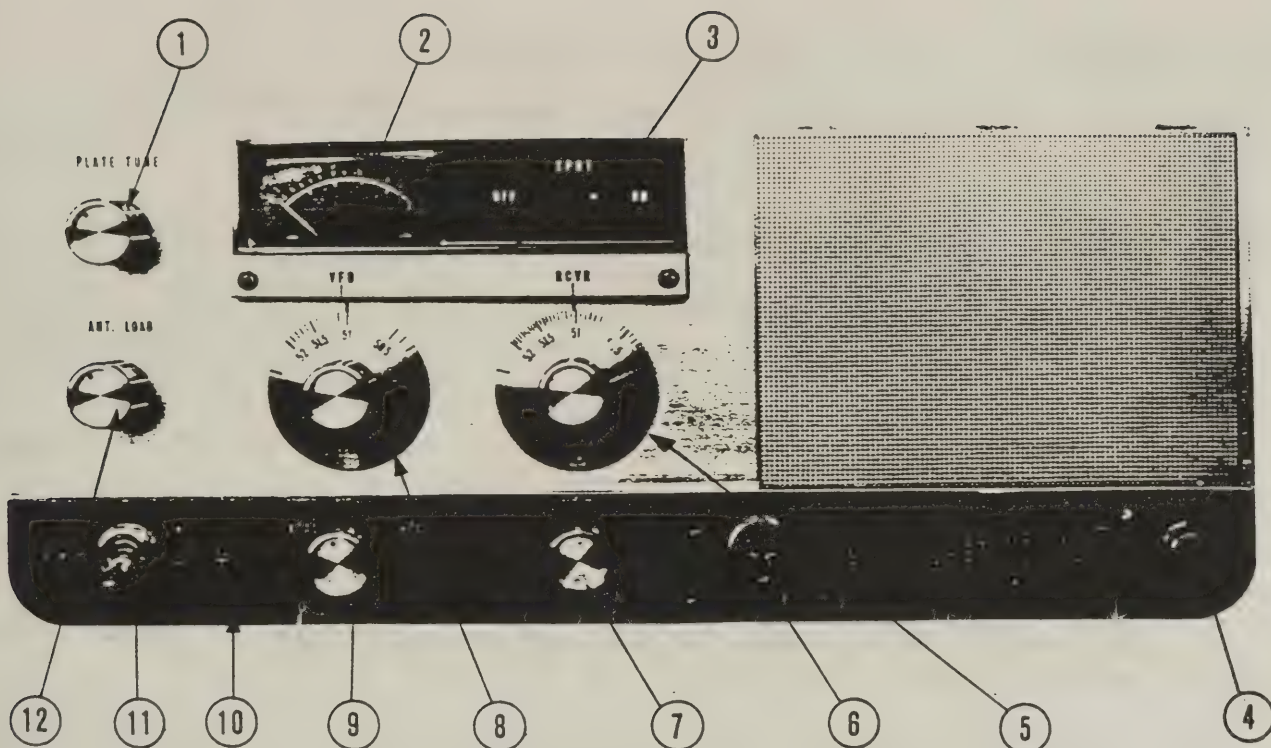


FIGURE 2—OPERATING CONTROLS, INDICATORS AND CONNECTORS (FRONT VIEW)

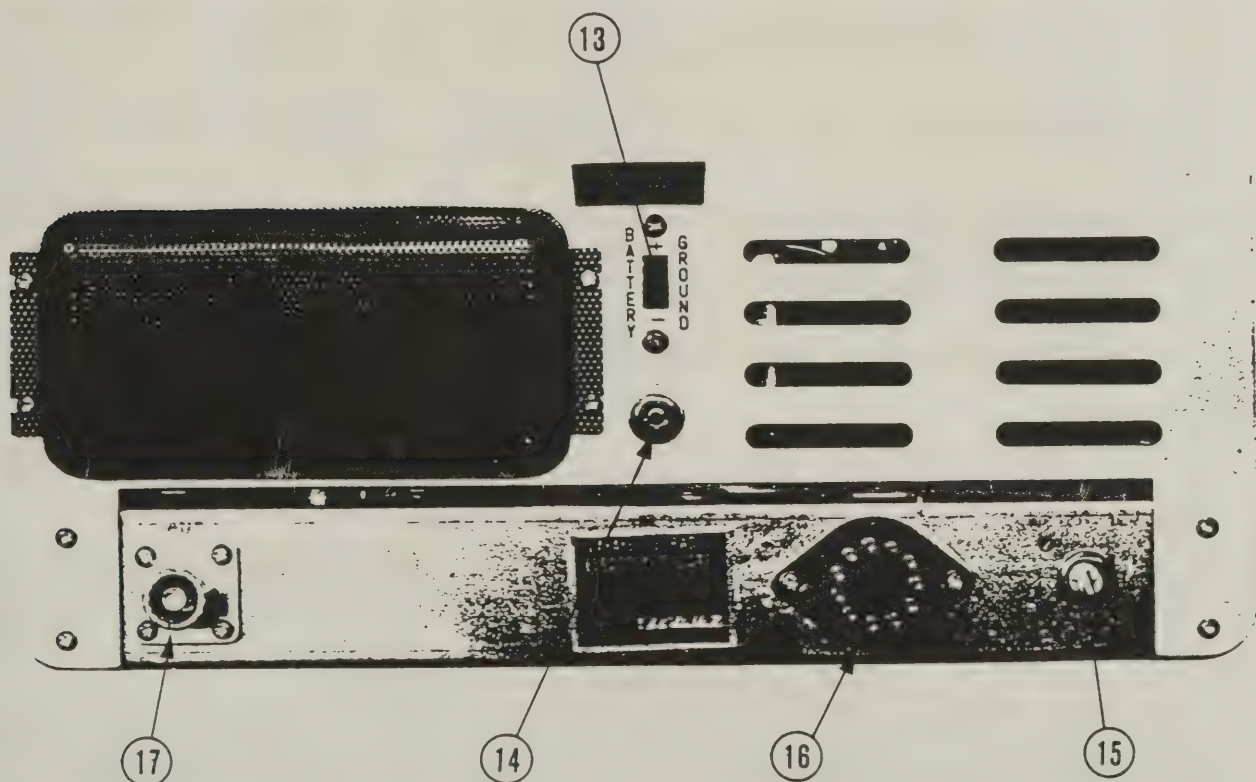


FIGURE 3—OPERATING CONTROLS, INDICATORS AND CONNECTORS (REAR VIEW)

TRANSMITTER OPERATION

To operate the transmitter portion of the HA-460 Transceiver, proceed as follows:

- (a) Connect antenna and power source.
- (b) Connect microphone to MIC receptacle on front panel.
- (c) Set XTAL-VFO switch to the desired mode of operation.
 - For crystal mode of operation, insert crystal in front panel XTAL socket. The frequency of transmission is six times the crystal frequency. Since the driver stage and VFO tuning condensers are ganged, tune VFO to the approximate frequency of operation to obtain maximum excitation to the final RF amplifier.
- (d) If the VFO mode of operation is chosen, tune the VFO tuning control to the desired frequency.
- (e) Pre-set the PLATE TUNE and ANT LOAD controls to mid rotation (black line up).
- (f) Set POWER switch to ON. The dial window should become illuminated indicating power is applied to the transceiver.
- (g) With microphone push-to-talk button depressed adjust PLATE TUNING and ANT. LOAD controls for maximum meter indication. Repeat adjustments until no further increase in meter reading is obtainable.

NOTE: Any time the operating frequency is changed, the PLATE TUNE and ANT. LOAD controls must be readjusted for maximum output.

- (h) The transmitter is now ready for transmission. To transmit press the push-to-talk switch on the microphone and talk into the microphone.
- (i) To locate the frequency of transmission on the receiver dial, set the SPOT switch to ON and tune the receiver until a strong unmodulated signal is heard. Then, return the SPOT switch to OFF and proceed with operation of transceiver.
- (j) NOTE: Transmitter will not operate with the spot switch in the ON position.

TRANSMITTER CRYSTALS

Crystals are available from Lafayette Radio, or any of the well-known crystal manufacturers. To order crystals proceed as follows:

1. Divide the desired operating frequency by 6 to determine the crystal frequency. Example: The desired operating frequency is 50.0 Mc

$$\frac{50.0}{6} = 8.333 \text{ Mc (crystal frequency)}$$

2. The crystal order to the manufacturer should contain the following information:
 - Crystal Type FT 243
 - Crystal Frequency Determined by formula in step 1.

THEORY OF OPERATION

INTRODUCTION

The following discussion of the theory of operation for the HA-460 Transceiver is divided into four parts. The first part discusses the theory of operation for the receiver portion of the transceiver. The second part discusses the theory of operation for the transmitter portion of the transceiver. The third part discusses the power supply. The fourth part discusses the S-Meter/Relative power indicator.

RECEIVER

Refer to the receiver block diagram, Figure 4, while reading the following discussion. If greater detail is desired at any point, refer to the schematic diagram,

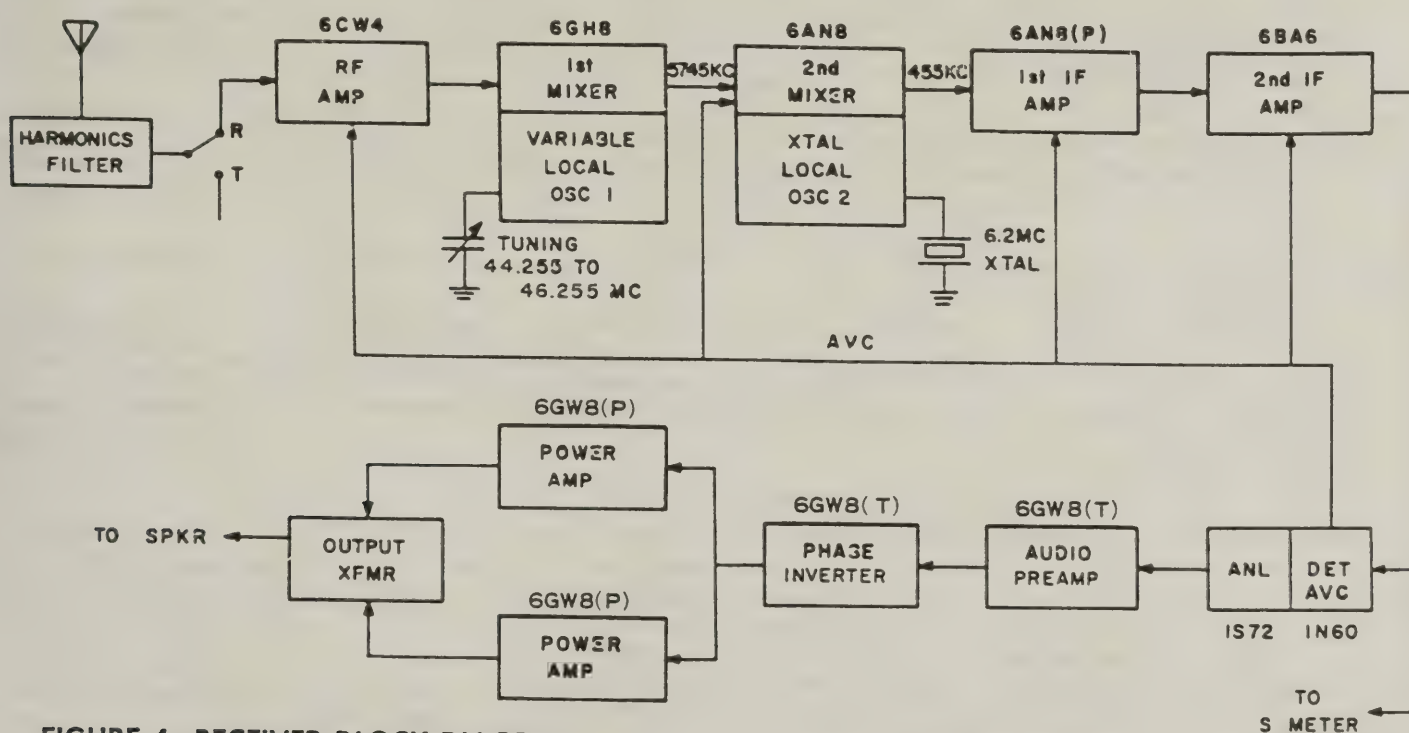


FIGURE 4—RECEIVER BLOCK DIAGRAM

NOTE: (P)=PENTODE SECTION
(T)=TRIODE SECTION

When an RF signal is applied to the antenna of the transceiver, it is fed through the harmonics filter and the change over relay K1 to the input of the 6CW4 RF amplifier. The 6CW4 RF amplifier is a low-noise Nuvistor stage.

After amplification by the 6CW4 RF amplifier stage the RF Signal is fed to the grid of the 6GH8 1st Mixer stage. The 6GH8 1st Mixer stage is the pentode portion of the 6GH8 tube. The triode section of this tube is variable local oscillator 1. The frequency of the local oscillator is determined by the setting of the TUNING control and it can be varied from 44.255 to 46.255 Mc. The output of local oscillator 1 is fed to the grid of the pentode portion of the 6GH8 tube where it mixes with the incoming RF Signal. The output of the 1st mixer stage is tuned to the first intermediate frequency which is the frequency difference between the two signals applied to its input.

The output of the first mixer V2 is fed to the grid of the pentode portion of the 2nd mixer (V3). The triode portion of V3 is a 6.2 Mc crystal oscillator. The output of the 6.2 Mc crystal oscillator is fed to the grid of the pentode portion of the 2nd mixer V3 where it combines with the 5745 Kc signal fed from the 1st mixer V2. The output of the 2nd mixer V3 is tuned to 455 Kc which is the second intermediate frequency.

The output of the 2nd mixer stage V3 is fed through two stages of IF amplification (V4 and V5) and then to a 1N60 diode detector. The 1N60 diode detector rectifies the IF signal to produce the audio signal and the AVC voltage.

After filtering the AVC voltage is applied to both 455 Kc IF amplifiers, the second mixer, and the Nuvistor RF amplifier to provide automatic volume control.

After filtering the audio signal is fed through a self-adjusting automatic noise limiter to the VOL control. From the volume control the signal is fed to the input of the first audio amplifier V7. After amplification the audio signal is fed to the grid of the triode section of the phase inverter (V6). The phase inverter processes the audio signal and feeds it to the grids of the pentode sections of two tubes (V6 and V7) which operate as push-pull power amplifiers. The output of the push-pull power amplifier is fed to the primary of the output transformer (T5).

The secondary of the output transformer (T5) has two windings. One winding is used to drive the receiver speaker. The second winding is used to modulate the transmitter when relay K3 is in the proper position.

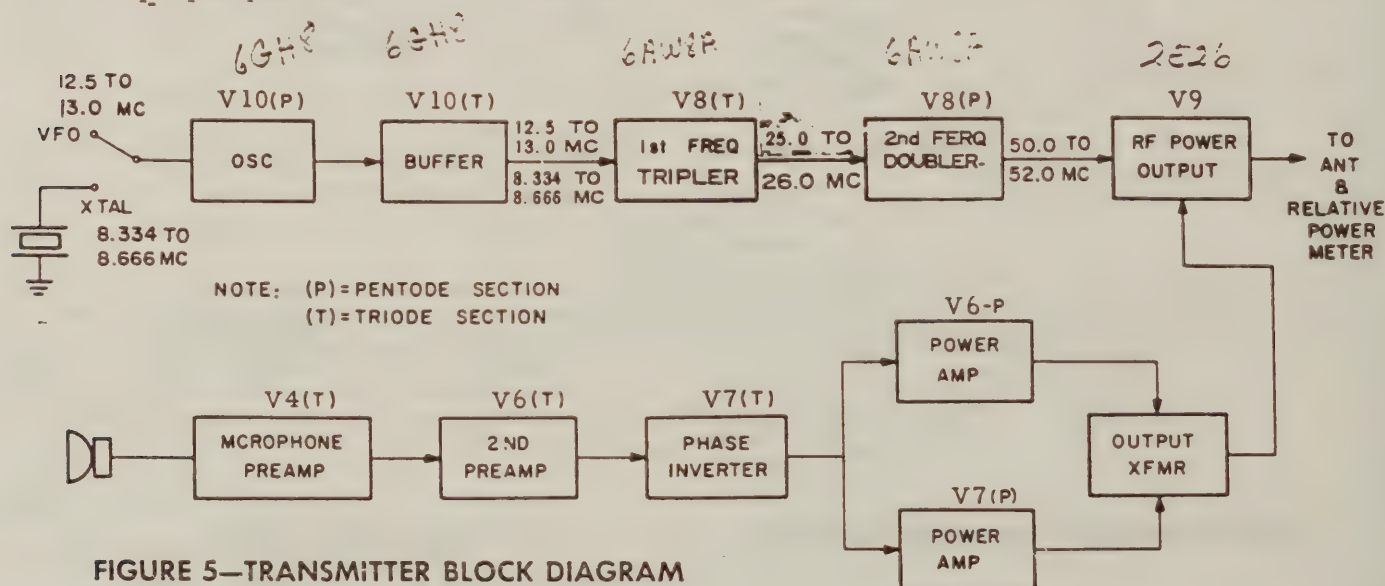


FIGURE 5—TRANSMITTER BLOCK DIAGRAM

TRANSMITTER

Refer to the transmitter block diagram Figure 5 while reading the following. If greater detail is desired at any point, refer to the schematic diagram.

The transmitter signal is generated in the pentode section of the oscillator/buffer stage V10. The oscillator may be either crystal-controlled or used as a VFO. The triode section of the oscillator/buffer stage V10 is a buffer amplifier used to isolate the oscillator from undesirable effects which might be caused by the loading of the following circuitry. The output of the buffer amplifier V10 is fed to the input of the first frequency doubler/tripler stage, triode section of V8.

In VFO mode of operation the fundamental frequency of the VFO is doubled. In crystal mode, the fundamental frequency of the crystal is tripled. The output is then fed into the input of the second frequency doubler stage, pentode section of V8.

The second frequency doubler stage doubles the frequency again. The frequency produced at the output of the second frequency doubler stage V8 is four times the VFO oscillator frequency and six times that of the crystal frequency. The output of the second frequency doubler is fed to the grid of the RF power output stage V9.

The RF power output stage V9 amplifies the signal further and supplies RF power to the antenna through a pi matching network and a harmonic filter.

To modulate the transmitter, an audio signal must be introduced into the microphone. When an audio signal is introduced into the microphone, it is amplified by the triode section of the microphone preamplifier V4. The output of the microphone preamplifier is fed to the triode section of the second preamplifier V6 where it is further amplified. The output of the second preamplifier is fed to the triode section of the phase inverter V7 where two 180° out-of-phase signals are produced to feed the push-pull power output tubes (V6 and V7). The output of the phase inverter is fed to the grids of the pentode sections of the power amplifiers (V6 and V7) which provides the power necessary for high level plate modulation.

The output of the push-pull power amplifiers is used to modulate the RF power output stage V9.

POWER SUPPLY

The power supply of the HA-460 is a universal type capable of operating from 117 volts AC or 12 volts DC power sources.

When operating from 117 volts AC power source, the power supply functions in the usual manner with the AC being applied to the power transformer and rectified by a full wave rectifier and its associated filter network (see schematic diagram).

When operating from a 12 volt DC source, four 2SB425 transistors are used to convert the DC to AC. The AC is then stepped up by the power transformer and rectified to produce the B+ voltage. A polarity reversing switch S1 (see schematic diagram) is furnished so that the power supply may be used on vehicles having either a positive or negative ground.

S-METER/RELATIVE POWER INDICATOR

A unique meter circuit is used to provide indication of operation in both the receive and transmit modes. In the receive mode, the screen current of the AVC controlled IF amplifier (V5) is measured by the meter. The indication is proportional to the AVC voltage (or incoming signal strength). The meter is calibrated in "S" units to 9 and in decibels above S-9.

In transmit, a small portion of the RF output signal is rectified and filtered. This rectified voltage is measured by the meter and gives an indication of the relative output of the transmitter.

TROUBLE SHOOTING HINTS

INTRODUCTION

In case a malfunction should develop in the HA-460, the trouble-shooting hints given in Table 2 can be used as a general procedure for locating the defective section of the transceiver. Once the defective section has been located, the voltage measurements given in Table 3 can be used as a reference to further localize the malfunction.

TABLE 2—TROUBLE SHOOTING HINTS

TROUBLE	WHAT TO LOOK FOR	WHAT TO DO
Unit inoperative Dial light not on	Power source not connected Open fuse in 12 volt DC power cord Defective power cord	Connect power source Check for short and replace fuse Replace power cord
Unit inoperative Dial light on Tubes lit	Open fuse in B+ power supply Defect in B+ power supply	Check for B+ short and replace fuse Check out B+ power supply and repair
Transmitter inoperative Receiver operating normally	Defective tube in transmitter section Defective microphone push-to-talk switch Defective change-over relay Defect in transmitter section	Check tubes and replace any found to be defective Check switch. Repair or replace as necessary Check relay and replace if necessary Check voltages in transmitter section using Table 3 as a reference
Receiver inoperative Transmitter operating normally	Defective tube or diode in receiver section Defect in receiver section	Check tubes and diodes and replace any found to be defective Check voltages in receiver section using Table 3 as a reference

TABLE 3—VOLTAGE MEASUREMENTS

TUBE	OPERATION	PIN NUMBERS											
		1	2	3	4	5	6	7	8	9	10	11	12
V1 6CW4	RCV XMT	--	80	--	NDV	--	--	--	0	--	H	--	H
V2 6GH8	RCV XMT	92	NDV	85	H	H	110	1.9	NDV	NDV	--	--	--
V3 6AN8	RCV XMT	48	NDV	0	H	H	115	116	NDV	2.7	--	--	--
V4 6AN8	RCV XMT	10	NDV	0	H H	H H	115	80	NDV	1.25	--	--	--
V5 6BA6	RCV XMT	NDV	0.55	H	H	55	57	0.55	--	--	--	--	--
V6 6GW8	RCV	NDV	0.5	295	H	H	292	5	-9.5	56	--	--	--
	XMT	NDV	0.55	245	H	H	240	0	-9	65	--	--	--
V7 6GW8	RCV	25	62	295	H	H	292	5	-9.5	205	--	--	--
	XMT	22	63	245	H	H	240	0	-9	172	--	--	--
V8 6AW8A	RCV XMT	0	NDV	240	H	H	0	NDV	185	240	--	--	--
V9 2E26	RCV XMT	0	H	155	0	NDV	0	H	0	--	--	plate	240
V10 6GH8	RCV XMT	175	NDV	175	H	H	235	0.2	0	NDV	--	--	--

NDV: No detectable voltage.

RETURNING THE UNIT FOR REPAIRS

In the event that repair is necessary (either in or out of warranty), we recommend that you return the transceiver to the Lafayette store from which it was purchased. If the unit is to be shipped to our main office for service, please read the instructions which follow.

SHIPPING INSTRUCTIONS

Pack the unit very carefully to avoid damage in transit, preferably in its original carton. If the original carton is not available, use a sturdy carton with at least 3 inches of shredded paper or excelsior around the unit. In the latter case, wrap the unit in paper first to avoid particles of packing material getting into it. Include with the unit a letter explaining exactly what difficulties you have encountered (remember to add an extra 5¢ postage and indicate on the outside of the carton that First Class Mail is enclosed). Ship by prepaid express if possible and mark ELECTRONIC EQUIPMENT - FRAGILE. Clearly address the carton as follows:

SERVICE DIVISION
LAFAYETTE RADIO ELECTRONICS CORP.
111 JERICHO TURNPIKE
SYOSSET, L.I., N. Y. 11791

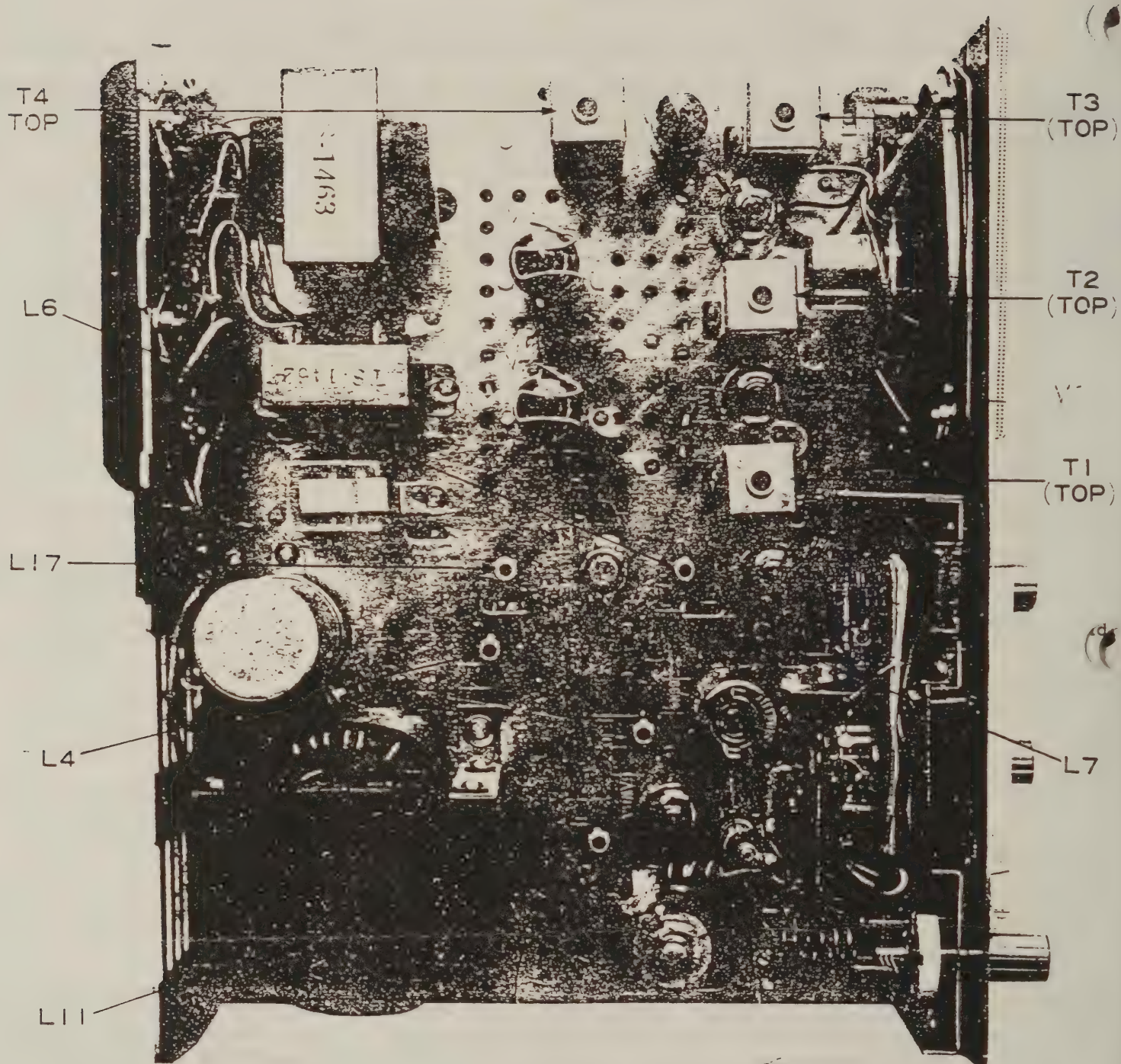


FIGURE 6—ALIGNMENT POINTS (TOP VIEW)

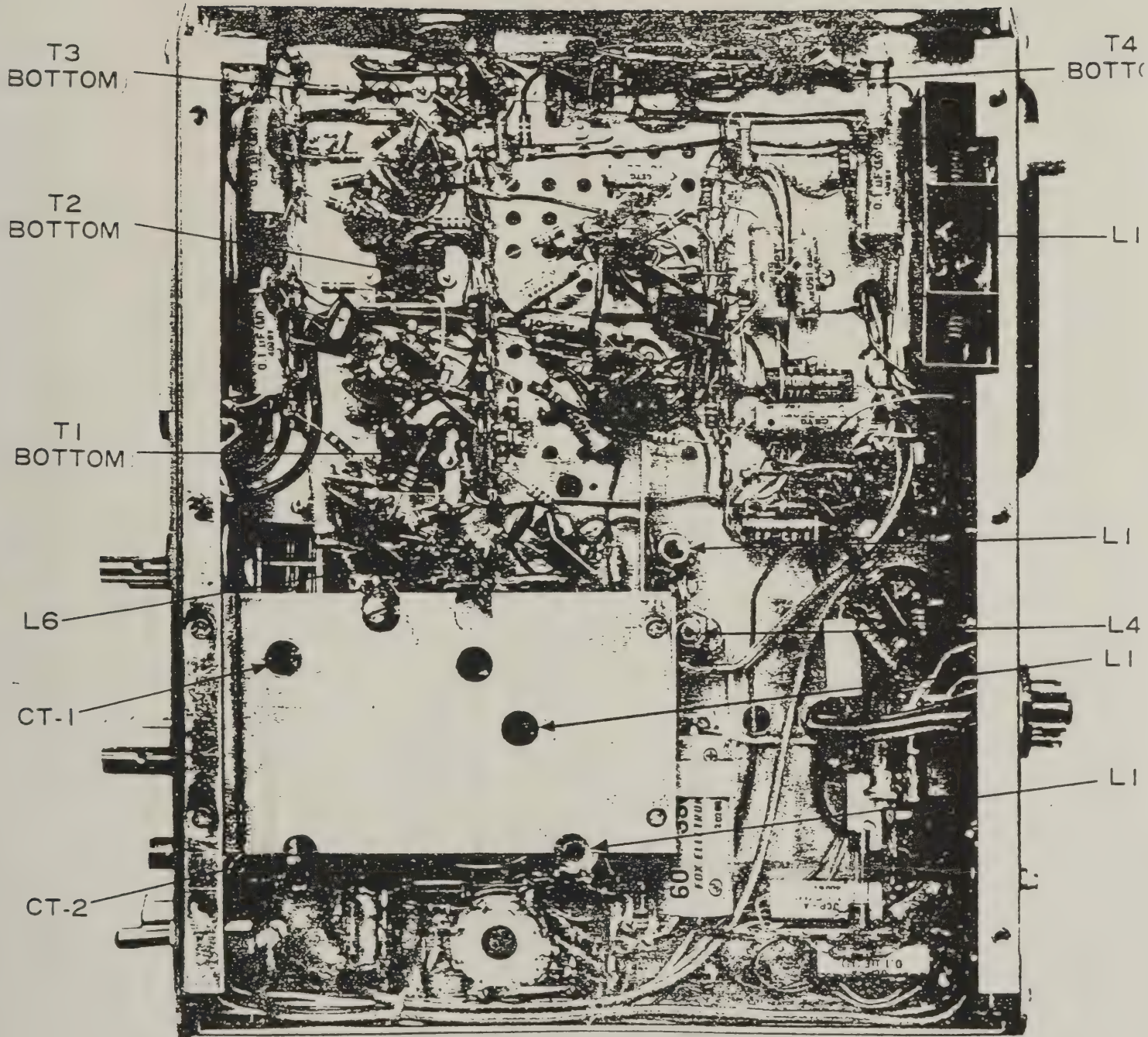


FIGURE 7—ALIGNMENT POINTS (BOTTOM VIEW)

ALIGNMENT

RECEIVER

To align the receiver portion of the HA-460 obtain the test equipment listed below and proceed as directed in Table 4.

Test Equipment Required: 1. Calibrated signal generator
2. AC VTVM
3. Non-metallic alignment tool

TABLE 4. RECEIVER ALIGNMENT PROCEDURE

Step	Purpose	S.G. Coupling & Input Signal	AC VTVM Connections	RCVR Dial Setting	A djust	Indication	Location of Alignment Point
1	Local Oscillator No. 1 Alignment	Connect S.G. to antenna input. (a) Set S.G. to 50.0 Mc (b) Set S.G. to 52.0 Mc (c) Repeat (a) and (b) until no further improvement is obtained.	Across Speaker Terminals	50.0 Mc 52.0 Mc	L7 CT1	Maximum output on AC VTVM "	See Figure 6 See Figure 7
2	Align 5745K IF transformer. Note: Ground pin 9 of V2 during this step. Remove ground after completing this step.	Connect S.G. to pin 2 of V2 and set it to 5745 Kc	Across Speaker Terminals	----	T1 (Top & Bottom)	"	See Figures 6 and 7
3	Align 455Kc IF transformers. Note: ground pin2 of V3 during this step. Remove ground after completing this step.	Connect S.G. to pin 8 of V3 and set it to 455 Kc	Across Speaker Terminals	----	T2, T3 and T4 (Top & Bottom)	"	See Figures 6 and 7

4	RF Amplifier Alignment	Connect S.G. to antenna input and set it to 51.0 Mc	Across Speaker Terminals	51.0 Mc	L6 then L17 then L4. Note: Repeat adjustments until no further improvement can be obtained.	"	See Figures 6 and 7
5	Adjust S-meter	Connect S.G. to antenna. Set it to 51.0 Mc with an output of 50 microvolts	----	51.0 Mc	Meter Adj. Pot.	S9 on S-meter	See Figure 3

TRANSMITTER

To align the transmitter portion of the HA-460 obtain the equipment listed below and proceed as directed in Table 5.

Equipment Required: 1. Milliammeter (Simpson Model 260 or equivalent)

2. 8.5 Mc crystal. Note: Any crystal which will produce an output frequency between 50.0 and 52.0 Mc may be used. The proper adjustments must be made in Table 5 to compensate for using a crystal with a frequency other than 8.5 Mc
3. Non-metallic alignment tool
4. Ten watt dummy load
5. TV Receiver

TABLE 5. TRANSMITTER ALIGNMENT PROCEDURE

Step	Purpose	Alignment Conditions	VFO Dial Setting	Adjust	Indication	Location of Alignment Point
1	Align Transmitter VFO	1. Insert 8.5 Mc xtal into XTAL socket and set XTAL-VFO switch to XTAL 2. Set SPOT switch to ON and tune receiver until unmodulated signal is heard. 3. Set XTAL-VFO switch to VFO	51.0 Mc	CT2	Zero beat as heard on receiver	See Figure 7
2A	Align driver stage	1. Connect 10 watt load to antenna connector 2. Connect milliammeter between "Test Point" (See schematic) and ground 3. Tune PLATE TUNE and ANT, LOAD controls for maximum output	51.0 Mc	L10 and L11	Maximum grid drive on milliammeter. Note reading.	See Figure 7
2B		1. Retune PLATE TUNE and ANT, LOAD controls for maximum output.	52.0 Mc		Note milliammeter reading.	
2C		1. Compare readings obtained in steps 2A and 2B. Carefully trim L11 until grid drive is equal at 50.0 and 52.0 Mc. *		L11	Grid drive as shown on Milliammeter	
3	Align harmonic filter	1. Use TV set tuned to channel 2 as an indicator 2. Energize transmitter and observe TV set	51.0 Mc	L1	Minimum interference on TV set	See Figure 7

* NOTE: When L10 and L11 are properly adjusted, the grid drive to the 2E26RF out, tube will be somewhat lower on either end of the band as opposed to the middle (50.0 and 52.0 Mc as opposed to 51.0 Mc).

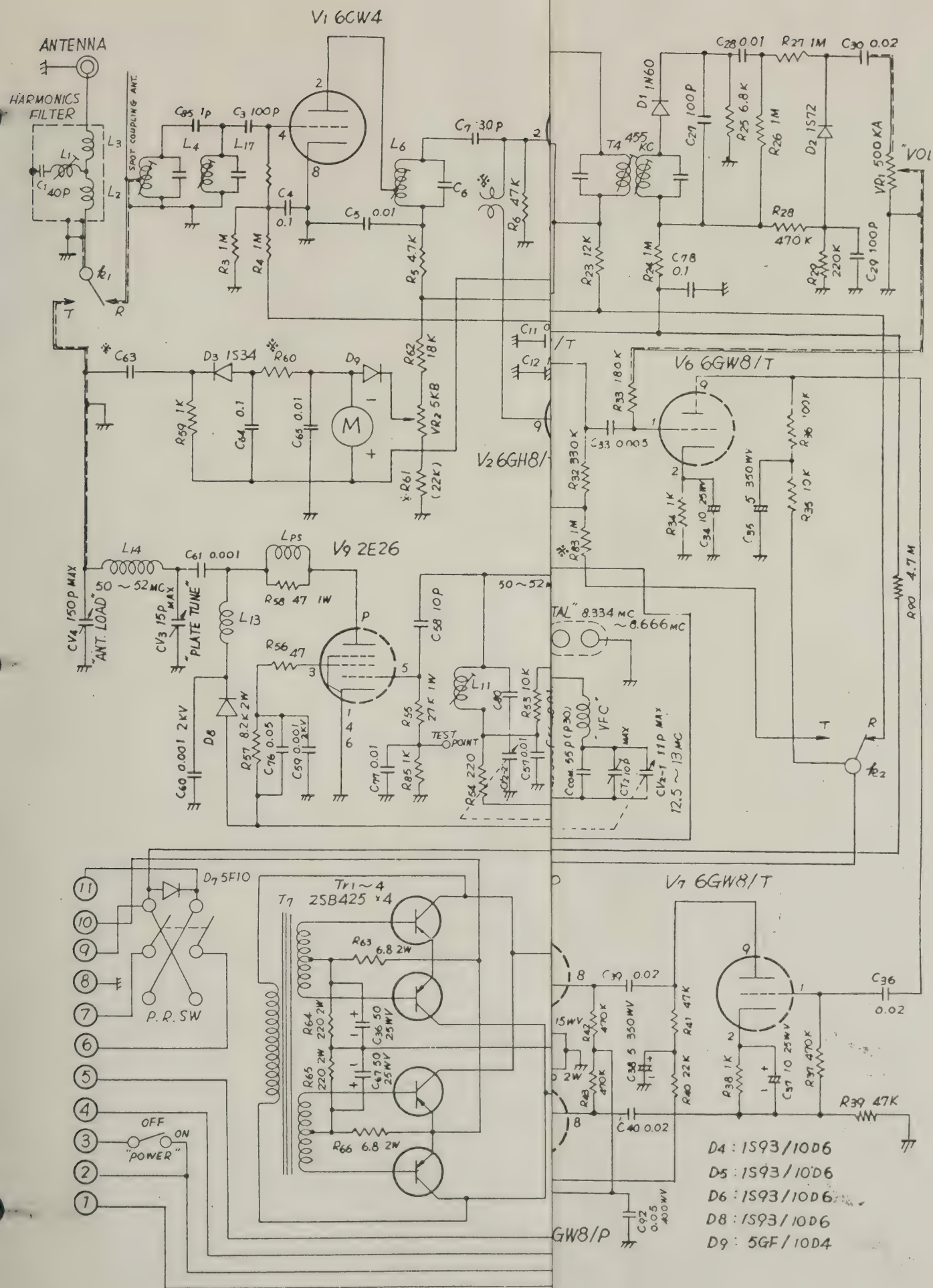
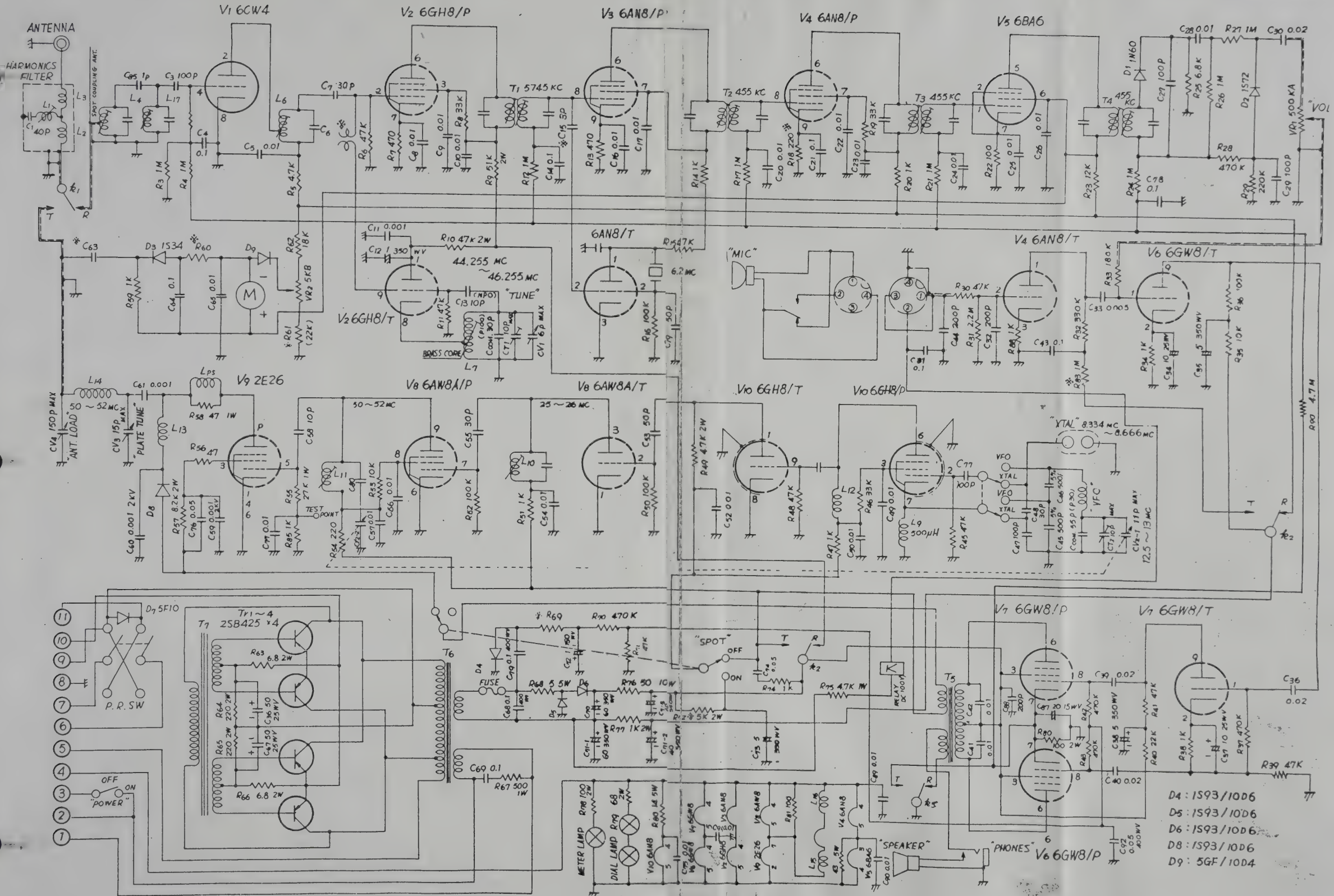


TABLE 5. TRANSMITTER ALIGNMENT PROCEDURE

Step	Purpose	Alignment Conditions	VFO Dial Setting	Adjust	Indication	Location of Alignment Point
1	Align Transmitter VFO	1. Insert 8.5 Mc xtal into XTAL socket and set XTAL-VFO switch to XTAL 2. Set SPOT switch to ON and tune receiver until unmodulated signal is heard. 3. Set XTAL-VFO switch to VFO	51.0 Mc	CT2	Zero beat as heard on receiver	See Figure 7
2A	Align driver stage	1. Connect 10 watt load to antenna connector 2. Connect milliammeter between "Test Point" (See schematic) and ground 3. Tune PLATE TUNE and ANT. LOAD controls for maximum output	51.0 Mc	L10 and L11	Maximum grid drive on milliammeter. Note reading.	See Figure 7
2B		1. Retune PLATE TUNE and ANT. LOAD controls for maximum output.	52.0 Mc		Note milliammeter reading.	
2C		1. Compare readings obtained in steps 2A and 2B. Carefully trim L11 until grid drive is equal at 50.0 and 52.0 Mc. *		L11	Grid drive as shown on Milliammeter	
3	Align harmonic filter	1. Use TV set tuned to channel 2 as an indicator 2. Energize transmitter and observe TV set	51.0 Mc	L1	Minimum interference on TV set	See Figure 7

* NOTE: When L10 and L11 are properly adjusted, the grid drive to the 2E26RFF out, tube will be somewhat lower on either end of the band as opposed to the middle (e.g.: Lower at 50.0 and 52.0 Mc as opposed to 51.0 Mc).



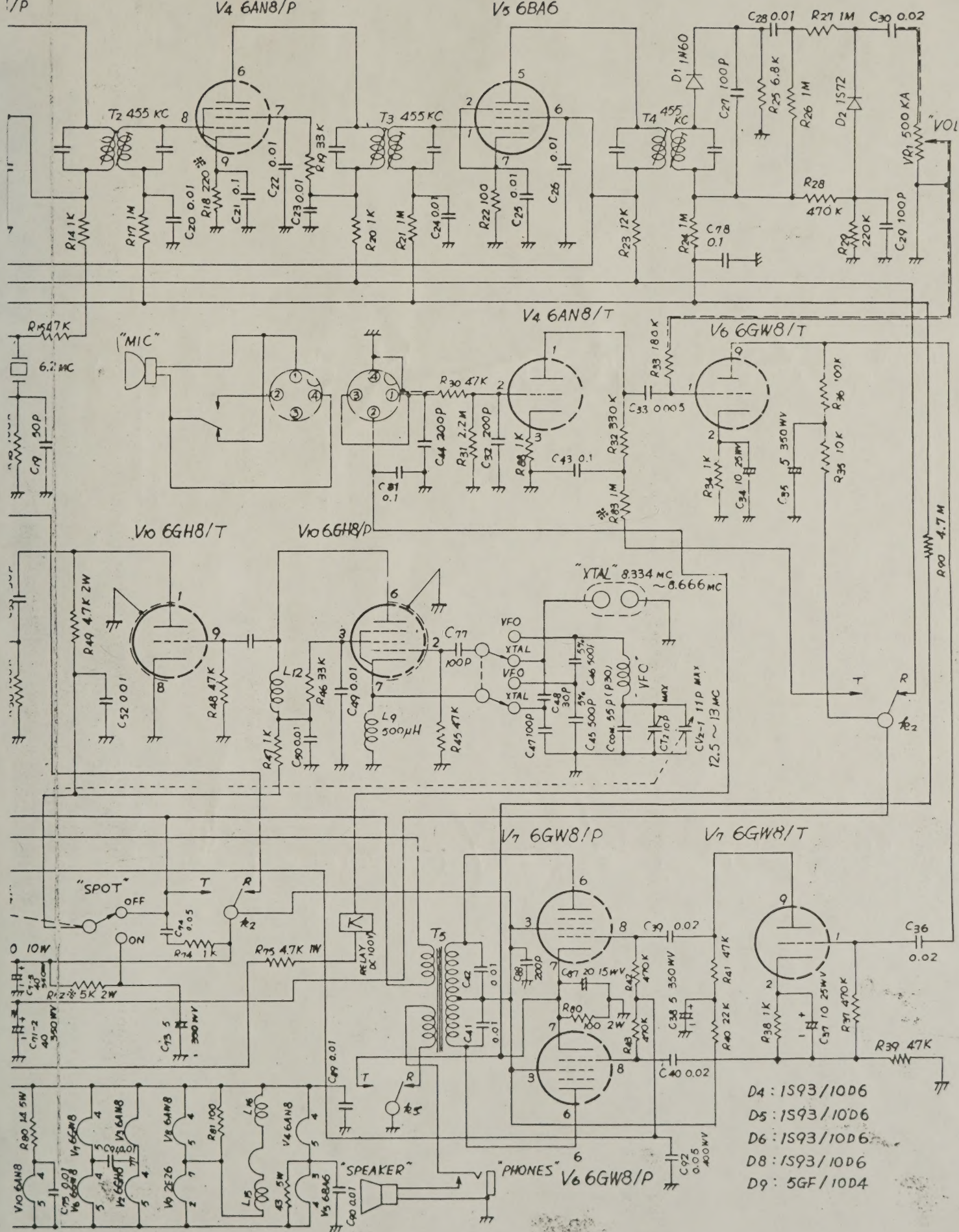
- D4: 1S93/10D6
- D5: 1S93/10D6
- D6: 1S93/10D6
- D8: 1S93/10D6
- D9: 5GF/10D4

* SUBJECT TO CHANGE IN INDIVIDUAL UNITS

1/P

V4 6AN8/P

V5 6BA6





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